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NOTHING VENTURE

In addressing the tenth international congress of the International Union of Producers and Distributors of Electricity, Sir Christopher Hinton, managing director of the United Kingdom Atomic Energy Authority Industrial Group, gave the members the advice not to go too fast in the development of plant to produce electricity from nuclear energy. What their consumers wanted was cheap electricity ; but they would get that, not by rushing into over-advertised new developments, but rather by carefully assessing the developments and making absolutely certain that while they did not adopt new ideas later than was advisable, they equally did not adopt them before they had a sound commercial footing. Clearly, from the trend of his further remarks, Sir Christopher had it in mind that were some new form of nuclear power plant to fail to live up to its promises, and even more so were it to suffer a disaster, the whole future of the development of nuclear power might be compromised and the rate of further advance be retarded. Obviously he is right. For, despite a spate of material recently published about nuclear physics and its application, the public is still ill-informed. In particular it is both ignorant about and nervous about radioactivity, as, indeed, was revealed at the time when it was proposed to dispose of certain radioactive wastes in disused pits in the Forest of Dean. Were there to be within the next few years any disastrous occurrence at a nuclear power plant—it has to be remembered that not all nuclear power reactors are as inherently safe as those being installed at Calder Hall—public reaction might well prove to be so extreme as practically to bring further advance to a halt. At the very least the public would very probably demand that work be confined to the development only of inherently safe installations. The result would be to handicap this country's industry in its attempt to enter world markets for nuclear reactors.

Sir Christopher, of course, is in an advantageous position for giving such excellent advice. The researches that led to the possibility of generating power from atomic nuclei grew out of the immense expenditure of public money on the development of atom bombs ; and the work has always had full financial support from the Government. That support has been regularly maintained through all stages of development up to the creation of a full-scale commercial power station. It is, however, noteworthy that with an honourable exception or two, little interest was shown in the work by industrial firms until very recently. Had the research had to be done only with such financial support as could be won from industry and private investors it might have had to take a very different course. The U.K.A.E.A. industrial group has been able to proceed cautiously because the financing of its operations was assured. Less fortunate workers in other fields may be driven by the need for finance to make advances less safely. For, unless they can raise money the work cannot go forward ; and only a spectacular demonstration at an early stage that their work holds out a high promise of success may prove sufficient to attract industry and speculators to risk their money on the venture. Normally, in fact, the timing of advances is something that engineers cannot wholly control. It may be, as Sir Christopher suggested, that in installing the first steam engine to work with steam under pressure on the banks of the Thames, Trevithick was running ahead of the materials at his disposal with the consequence that there was an explosion and eight men were killed. But unless the advantages of steam under pressure could be demonstrated no financial support would have become available towards the development of better materials and better boiler designs. Bleriot was more successful in a venture at least equally hazardous at the time he undertook it. But his flight across the Channel demonstrated the promise of aeronautics and caught the attention not only of talented men who entered the field of aircraft design but also of men willing to risk their capital.

The timing of advances is, too, affected for engineers in another way. Competition ensures that every manufacturer shall strive to outstrip others by rapidly advancing designs and, if possible, cheapening his products. This process has its dangers, too. Despite the sad example of Trevithick's early attempt to use steam under pressure, we find, seventy or so years later, that early volumes of this

journal are littered with descriptions of burst boilers ! In truth engineers have always been willing to accept hazards. To this day, and we hope for many years to come, they will make advances without waiting for scientific proofs of safety. Even in Sir Christopher's own work there has been, through lack of precise knowledge, much inspired guesswork through which conclusions have been reached, despite an incomplete array of facts. Calculated risks have been taken in the sure belief that much can be learned only by taking such risks. For even theories cannot be regarded as established until a trial has been made of them ; and very much theory is based upon, indeed enshrines, past experience. Engineers, for example, knew nothing about torsional oscillation until crankshafts, apparently conservatively designed by the best practice of the day, began mysteriously to break. Creep only became a subject for study when pressures and temperatures were pushed so high that troubles from that cause were experienced. The corrosion of economiser tubes came upon engineers unawares when pulverised fuel began to be extensively used. Little could be learnt about the stresses falling on aircraft skins and control surfaces until aircraft began to fly. Every machine or device that exceeds in some direction anything done before is bound to be in some degree experimental.

There are, of course, always those, particularly amongst their contemporaries, who will say that adventurous people are merely over-hasty ; that they had only to wait a little for the risks they undertook to be reduced. But is it altogether true? For three things are often demonstrated by such ventures. One is that the machine involved is far from ideal for the job undertaken, which, indeed, everyone knew. A second is that despite its unsuitability it can, nevertheless, do the job, which is inspirational to further effort towards improvement ; and the third is that the desirable directions of further improvement are thrown up in sharp relief. It seems to us significant, also, that in looking back on the past our sympathies lie not with the timid who dared not but with the bold who would not be held back. Over high pressures Trevithick is a much more inspiring figure than the more cautious Watt. Brunel is as much honoured for his failure, the "Great Eastern," as for his equally spectacular successes. We have erected a statue to Alcock and Brown at London Airport. It is not regarded as a disgrace to have been associated with the designs of airships "R100" and "R101." Sooner or later the timid—amongst whom we hasten to add, we certainly do not include Sir Christopher—will find cause, no doubt, to criticise pioneers who first venture on a flight to the moon in a craft barely capable of undertaking a return journey. Yet until that journey has been made the true and total nature of the hazards to be faced can only be guessed at and essential facts may be lacking for the design of safer space craft.

PERSONALITIES AND REPUTATIONS

How simple an engineer's life would be if he was able to assume that all the many technical decisions that have daily to be taken are certain to be reached solely on the basis of technical merits ! In fact, of course, it is not a tenable assumption. A buyer, for example, has to temper his enthusiasm for what he judges to be the better technical designs by remembering that he can buy only what he can afford ; when capital as well as running costs have been assessed what seems technically the best machine may turn out not to be the most economical for the purpose in view. Again, a great many users of engineering products are not themselves engineers. They have not the knowledge to make a choice of plant on the grounds of the technical merits of competing designs. What, then, can they do ? If they are wise they will do more than assess from sales literature which of many devices offered to them is the better. They will attempt by consulting their suppliers and their friends to learn the reputations of the manufacturing firms involved. If a firm's reputation is not as high as it might be, it will then go hard with it to get the order even at an advantageous price ! But good reputations are things acquired through the work of a company's servants in the past. They are sustained, heightened or lowered by the living servants of the company. That is a fact well known to those who place very large orders for plant. Those buyers will want to know not only what is the reputation of a firm, but whether it is still being sustained. They will make their judgment on the basis of the quality of the men they meet in discussing the details of a projected contract. The order goes not to the firm that promises most, not to that which has the highest present reputation, but to that whose technical men best impress the buyer. In short, in this engineering work of ours technical decisions are shot through and through by assessments not solely of technical merit, but also of the personalities involved.

Nor is this true only of the buyer and seller relationship. It rules also within any organisation wherever a technical decision more than ordinarily difficult has to be taken. Usually, when a decision has to be reached about, say, some aspect of a new design or how to tackle a machining problem, or how best to concentrate limited research facilities upon particular projects, discussion of the technical pros and cons will give satisfactory guidance. But not always ; sometimes, because certain features are unknown or because estimates are of dubious reliability, advantages and disadvantages, technically, seem nicely balanced. On what grounds, then, is the ultimate decision reached ? Usually, we suggest, on an assessment of the personalities involved. The decisive factor will be somebody's judgment of the skill and reliability of the protagonists of various courses of action. Usually, the advice will be followed of the man or men whose judgment has been proved sound during many years of service. Personal reputations count for something within the firm as well as without! Yet, often, the choice may be made on more subtle grounds. For if advice from older men of established reputation were always followed younger men might justly complain that they never had the chance to win their spurs. To give talented, but inexperienced youth its head is certainly less safe, but may be wiser. It may prove wiser even if the man in whose hands decision lies leans in opinion to the views of his older and well-trusted servants. For many a brilliant youngster has been lost to a firm that he would later have served with distinction by having his enthusiasms damped and his energies frustrated. It is better that he should learn from his mistakes than that he should be denied the opportunity to make them ! It is, indeed, we think, as much by balanced judgment of men as by correct judgment of technical problems that great men like Parsons and many others built up great businesses. For it is almost a truism that great men attract talented teams around themselves.

Maybe it is an appreciation of the importance of making judgments of human ability that deludes some people into supposing that the head of a great organisation needs no technical understanding of it so long as he is experienced in administration. We cannot believe it. For if an organisation is to attract to itself talented men they will expect its head to create technical policy rather than merely select between opposing policies ; to give due weight to the technical merits of their proposals, rather than to choose on grounds of character alone ; to be capable of technical criticism and able to phrase penetrating comments ; in short, to be the leader of a team rather than merely a referee keeping order and needing to rely upon personal judgments only when no other resource is open to him. Moreover, how is an non-technical administrator to choose on personal grounds alone between the competing views of, say, a strong personality given to exaggerated enthusiasms, sometimes firmly based, and the indecisive preferences of a milder man technically as able, but more pedestrian in outlook ? The decisions of a man not technically trained must prove capricious, and if in technical matters he relies entirely upon the judgment of a subordinate then in those matters he yields his leadership. Engineering concerns, we believe, best flourish when headed by engineers.

A Seven Day Journal

Retirement of Mr. V. A. Pask

WE learn that Mr. Vincent A. Pask, chief engineer of the Central Electricity Authority, will retire in December next after 45 years' service in the electricity supply industry. He was born in Manchester, and acquired his technical education at the Preston Technical College. His early training and experience were gained in the Tramway and Electricity Undertakings of the Preston Corporation. Then, in 1920, after service in the Paisley, Hull and Bootle Municipal Electricity Undertakings, he was appointed deputy general manager and engineer of the Newcastle and District Electric Lighting Company, Ltd. Having served for twelve years in that capacity he became city electrical engineer of Norwich ; there he was responsible, amongst other things, for much pioneering work in rural electrification over a large portion of the County of Norfolk. Early in 1940, Mr. Pask joined the staff of the Central Electricity Board as manager of the Mid-East England Area and three years later he also took over the management of the North East England Area. In January, 1946, he came to London to become personal assistant to the late Sir Johnstone Wright who was general manager and later chairman of the Central Electricity Board. When the electricity supply industry was nationalised, under the 1947 Act, Mr. Pask accepted his present appointment as chief engineer of the Authority in November, 1947, and became responsible for the engineering direction of the largest integrated electric power generation and transmission system in the world. It may be recalled that, during his tenure of office, forty-one new power stations have been brought into commission and the installed capacity of generating plant has been raised from over 12,500MW to over 20,000MW, while the new 275kV supergrid transmission system has been designed and is now under construction.

Factory for Electrodeposition in Huddersfield

AT Huddersfield, last week, a newly-built factory for Fescol, Ltd., London, N.7, for the electrodeposition of metals, was formally opened by the mayor, Councillor John T. Gee, J.P. Sir James Reid, chairman of the company, replying to the opening speech, gave some details of the development of the firm and the growing demand for its service to industry. This is the second Fescol factory to be opened during 1955, and in addition to headquarters in London, there are now factories in Port Glasgow, Brownhills (Staffs), and also a company formed in France (Société Fescol) which operates the process under licence. The new factory, known as Springbank Works, has a floor area of 14,000 square feet and replaces the former premises at Cable Street which the firm had occupied for fourteen years. It is of brick with reinforced concrete floor and roof, the double-storey frontage containing offices, laboratory, &c. The main works are well-designed to give efficient ventilation, good natural as well as artificial lighting, and ample working space, complete with hoists and handling aids. The building is painted with chlorinated rubber paint and the deposition areas floored with acid-resisting asphalt. Fumes from the process are extracted by ducting and high-speed fans and special provision has been made for the air supply for general ventilation and cooling purposes. The electric power for the chromium depositing vats is supplied separately to each vat by an oil-immersed "Westalite" rectifier set, each set having an output of 1500A at 12V, and being completely self-contained with its own auto-transformer and control gear. Each of the six vats can electrodeposit a superficial area of about 6 square feet at one time. The power supply for the vats for the deposition of nickel is obtained from motor-generator sets which have a total output of 3000A at 10V. A stand-by battery with a capacity of 4000A at the ten-hour rate is provided for use in case of power failure. Both the chromium and the nickel vats can deal with shafts and components up to 8ft in length, although 4ft 6in is the maximum length which can be treated in one operation. The factory is also equipped for machining any components requiring attention before or after depositioning. Among examples of typical applications of the Fescol process on view were hydraulic rams, rolls for textile and paper industries and cylinders for two-stroke engines. There were also examples of deposits for corrosion resistance and the reclamation of worn parts, which are both major applications of the process. The factory is specially equipped for the deposition of chromium direct on to all light alloys so that the deposit becomes an integral part of the base metal and does not rely on an undercoat of a second metal to ensure adhesion. This new process has received Ministry of Supply approval for use on aluminium and aluminium alloys used in the construction of aircraft and aircraft equipment.

List of Centenarian Firms

In a Centenary Number to be issued to mark the Centenary of this journal on January 4th next year there will be included a list of British manufacturing and consulting firms, institutions and societies and journals operating in the fields covered by "The Engineer" which will have celebrated their Centenaries by January 4, 1956. To ensure inclusion in the list each such firm or society in the engineering and allied industries, the iron and steel industry, the shipbuilding industry, and any other industries whose activities are commonly reported in "The Engineer," should inform us about the date of its foundation, its title at that time and its present title, before October 7th next, addressing the communication to The Editor, "The Engineer," 28, Essex Street, London, W.C.2.

Convention on Materials Handling

THE second national convention and demonstration of the Institute of Materials Handling will be held on Thursday, October 6th at the Royal Air Force Station, Hartlebury, Worcs. This year the theme of the convention will be "Simple Conveying and Controls with Ancillary Equipment." In the course of the convention three papers will be presented—"The Elements of Good Materials Handling and the Development of Basic Principles from an Exercise in Inter-Process Handling," by Mr. A. E. Holmes ; "The Indexing Conveyor," by Mr. O. J. B. Orwin, and "Simple Controls," by Mr. A. Ellis Hoult. A number of demonstrations with conveying equipment and controls which have been arranged will be accompanied by a running commentary, and facilities have been made available for visitors to inspect the equipment used. A "brains trust" has been organised to give members an opportunity to ask questions of a team of experts on mechanical handling. In organising this convention, the Institute has had the joint collaboration of Fisher and Ludlow, Ltd., Radiovisor, Ltd., and Conveyancer Fork Trucks, Ltd., and products of each of these firms will be seen in the demonstrations.

Amended System of Traffic Signs

CERTAIN amendments in the present system of traffic signs, now in general use throughout the country, are proposed by the Ministry of Transport and Civil Aviation. A draft booklet has been printed by the Stationery Office in which the proposals are set out in detail, and the Ministry has invited comment from various interested bodies. When comments have been received (by November 30th) the regulations will be laid before Parliament before they become effective. The size, colour and symbols used for the traffic signs are specified in detail, and the circumstances in which they may be erected, and under whose authority, are laid down. Several signs not now in common use are included in the new list. "Crossroad" and "bend" signs have been modified, and the torch symbol for "school" and "children" signs has been discontinued and pictorial signs substituted. A comprehensive system of carriageway marking has been adopted, and there are various other modifications and additions.

Fuel Efficiency Exhibition

AT a conference held by The Combustion Engineering Association on Wednesday of last week, Sir Miles Thomas, the chairman of the British Overseas Airways Corporation, had something to say regarding the Fuel Efficiency Exhibition which he is to open at Manchester on Wednesday, October 12th. During the course of his remarks he emphasised the importance of the efficient use of fuel and commented that the fuel situation was a governing factor in our economic life. The fact that this country no longer exported coal but imported it underlined that our coal reserves no longer ensured that our fuel supplies were safe. He regretted the expenditure of dollars to buy coal and that our expanding use of oil made us less independent of the rest of the world. Apart from the future possibilities of nuclear energy, the present situation meant that the industrialist must save himself by the economic use of fuel; the means to do so were available but Sir Miles thought that up-to-date engineering knowledge rather lagged behind with regard to the generation and use of steam. Increasing industrial demand for power made it a matter of urgency that inefficient use of fuel should be halted for failure to do this, he said, would inevitably create a position calling for the restriction in the use of fuel with a resultant adverse effect upon productivity. Sir Miles concluded his remarks by briefly calling attention to the work carried out by the two sponsors of the exhibition, namely, the Combustion Engineering Association and the National Industrial Fuel Efficiency Service.

Engineering, Marine and Welding Exhibition

No. III—(*Concluded from page* 397, *September* 16*th*)

LAST week, the twentieth Engineering, Marine & Welding Exhibition came to its close at Olympia, in London. Our description of the exhibition concludes in the following pages.

THE ENGLISH ELECTRIC COMPANY, LTD.

The English Electric Company, Ltd., Marconi House, Strand, London, W.C.2, exhibited a full range of a.c. arc welding equipment, including single and multi operator units, a 60kW r.f. induction heater with a pin and bush hardening machine and examples of class "LY" fan cooled motors together with a sectioned model of the new class "LE" (protected) motors which are available in four frame diameters for horsepowers ranging from ½ h.p. to 25 h.p. The diesel engine division was represented by a 400kW mobile emergency diesel generating station on wheels, a sixteen-cylinder turbo-pressure-charged Vee engine developing 1800 b.h.p. at 750 r.p.m., and an eight-cylinder, Mark "SRKM," pressure-charged geared marine engine.

This engine, seen in Fig. 32, is a vertical, totally enclosed, four-stroke, trunk piston exhaust, turbo-charged engine having a bore of 10in and a stroke of 12in and is rated to develop 900 b.h.p. at 750 r.p.m., the brake mean effective pressure at this output being 126 lb per square inch. The engine, which is of enclosed monobloc construction, is non reversible and drives through a modern wheel drive oil operated reduction gearbox. Both the bedplate and the crankcase are one piece alloy-iron castings and cast alloy-iron is used for the wet cylinder liners and for the separate cylinder heads, each of which carries two nickel-steel inlet and two silicon-chrome exhaust valves. The aluminium alloy pistons have four pressure and two oil control rings; the connecting-rods are alloy steel drop forgings and the forged steel crankshaft is carried in pre-finished steel shell main bearings lined with high grade bearing metal. There is a fuel pump for each cylinder and gear pumps maintain pressure fed lubrication throughout the engine which is fresh water cooled on a closed circuit system, the jacket water passing through a fresh water-salt water heat exchanger.

THE HARLAND ENGINEERING COMPANY, LTD.

On its stand, The Harland Engineering Company, Ltd., Alloa, Scotland, showed examples of its range of pumps and other products including a model of a "Rotovalve." Rotovalves consist of three major components, a body, a plug and an operating mechanism, which actuates the plug axially for seating and unseating so that when the plug revolves there is no face-to-face friction. This fact together with low bearing pressures ensures easy closing or opening against full unbalanced pressure and there is no need for a by-pass valve. Another attribute is the anti-water-hammer characteristic, for when closing, 80 per cent of the port area is cut off in 40 per cent of the crosshead stroke.

The Fibroglide "stuff" pump has a casing with a vertical split on the centre line so that the outer half of the casing can be removed for impeller cleaning and inspection. The impeller vanes and volute are designed to eliminate choking and to prevent vapour locking through the release of entrained air. For pumping hard or soft solids in water the company showed a "Swallowglide" pump in which the impeller has vanes having specially formed scraper tips on their leading edges to dislodge and carry away solid matter from the working face and so eliminate clogging. Also shown was an "Electro-glide" single-stage pump which is capable of dealing with high heads and consists of two major components, a casing and an impeller fitted directly on to the motor shaft. The rigidity of the shaft prevents relative motion of the impeller, shaft and cap so that air drawing and access of water to the shaft with consequent corrosion fatigue are avoided. The impeller, of single entry overhung pattern, is "blind" at the suction end and the shaft mounting boss is extended through the gland to atmosphere and a renewable sleeve is fitted over the impeller boss where it passes through the gland.

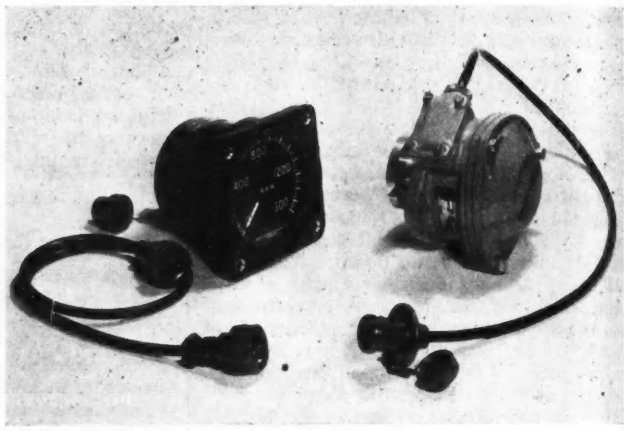


Fig. 33—4in square-fixing indicator and series "M" tachometer generator for use on oil well drilling rigs and traction diesel engines—Smiths Industrial Instruments

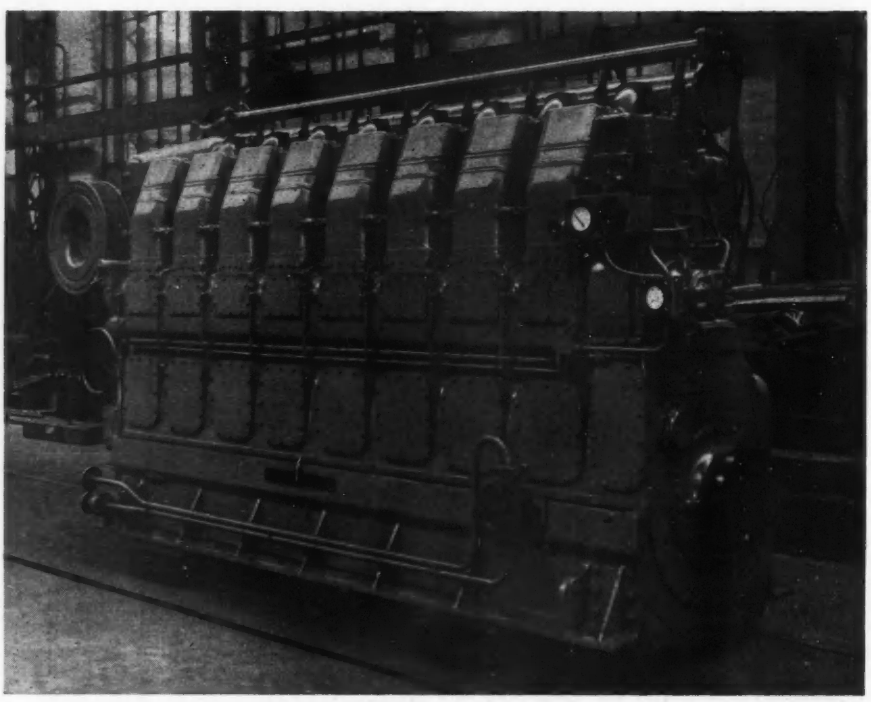


Fig. 32—Eight-cylinder pressure-charged diesel engine for geared marine propulsion—English Electric

SMITHS INDUSTRIAL INSTRUMENTS, LTD.

A tachometer generator designed for a variety of duties was one of the instruments shown by Smiths Industrial Instruments, Ltd., Chromos Works, North Circular Road, London, N.W.2. It is a single-phase a.c. tachometer generator (series "M") designed with various windings to cover speed ranges between 0 to 500 r.p.m. and 0 to 6000 r.p.m.; a single frame size accommodates all the generators in this series. They are suitable for use in connection with oil well drilling rigs and in rail traction, jumper connections being provided for multiple unit stock. A 4in square-fixing indicator and a tachometer generator with cable connections are shown in Fig. 33.

Rotational speeds measured by series "M" tachometer generators at six different places can be collated and recorded on a multi-channel electric recorder which was exhibited on the same stand. Recorders using the company's "Desynn" system of remote indication have various other applications involving the collation and presentation of information (from as many as six sources) such as angular position, linear position, fluid level, pressure and differential pressure.

Among the new tachometers shown was a direct-mounting, angle-type 12in magnetic tachometer which is specially designed for marine service and can incorporate a seven-figure counter if required. The display also

included new 6in, 9in and 12in electric tachometers with platform scales which are free from parallax errors.

Tecalemit, Ltd.

The lubricating equipment of new design made by Tecalemit, Ltd., Plymouth, included the "Impulse" pump, which has been developed as a simple, robust, single-delivery-line, lubricator, for heavy-duty machinery. A 6-pint design of this pump is illustrated in Fig. 34, which can be supplied for a fixed delivery of 5 cubic centimetres per stroke, or a variable delivery of from 1 to 5 cubic centimetres per stroke. The mechanism of a lubricator with a fixed delivery pump is shown in Fig. 35.

This consists of a simple, single-cylinder, ratchet-driven pump mounted on the side of a 6-pint rectangular container, fitted with four bolting lugs for mounting on a flat vertical surface. A screwed filler cap and strainer are set in the top panel, and a sight glass level indicator with a minimum level point marked, is incorporated in one corner of the container.

The pump assembly is attached by a flange incorporating the pump body, and consists of a single cylinder of large bore, the output per stroke being fixed or adjustable according to the model supplied. The piston suction stroke is actuated by a steep angle cam and rocker arm, the cam being attached to a ratchet drive wheel. The cam and ratchet wheel rotate on the main shaft, to which is anchored a pawl plate, carrying two spring-loaded drive pawls. One pawl is longer than the other in order to provide a half-tooth effect, and so shorten the minimum working angle of the drive lever. Two spring-loaded check pawls prevent reverse rotation of the ratchet wheel during the return stroke of the drive lever.

The drive lever, which is fitted at its outer extremity with a roller, is driven by an eccentric attached to the machine which is being lubricated. The working range of the drive lever is from 6 deg. minimum angle to 50 deg. maximum. A return spring ensures retraction of the drive lever ready for the next movement.

Each working stroke of the drive lever partially rotates the ratchet wheel and cam, and during rotation the cam gradually raises the rocker arm until the piston spring takes charge,

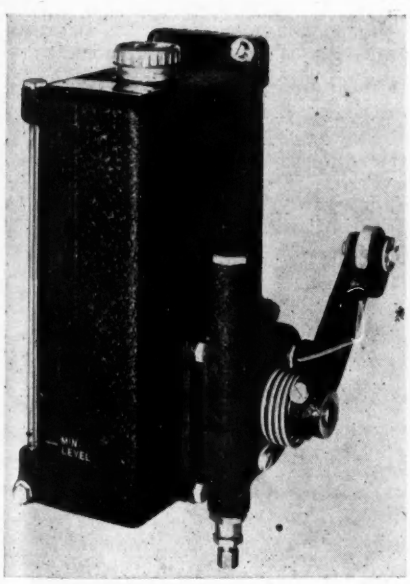


Fig. 34—6-pint ratchet operated lubricator—Tecalemit

at which point the cylinder is fully charged and the delivery stroke begins. The piston forces the charge of lubricant through the outlet check valve into the delivery line from which capillary lines of the desired capacities lead to the bearings where lubrication is being carried out.

In the adjustable output pump, instead of the rocker arm operating the piston direct, the free end is coupled to a crosshead in which the piston can be adjusted up or down. This is done by removing a split pin from the top of the cylinder outside the pump body, and rotating the adjuster head by means

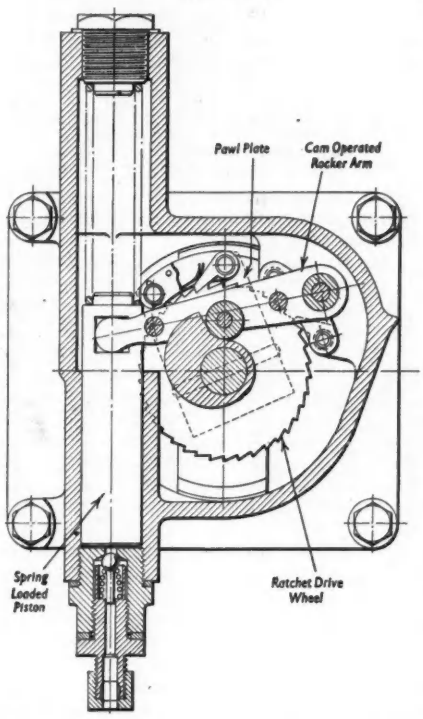


Fig. 35—Mechanism of lubricator pump—Tecalemit

of a screwdriver. The adjustment is made in half turns in order to replace the locking split pin, and the effect of the adjustment is to shorten or lengthen the piston stroke.

The firm has also introduced a new "falling drop" automatic lubricator which indicates the amount of oil being pumped. This lubricator has what is virtually a two-stage pump. In the first or low pressure stage oil is pumped into a sight feed tube through which the output can be observed in "drops." The "drops" fall into a collection tube which conveys the oil into the second or high pressure stage where the oil is pumped into the outlet connection.

The low pressure pump stage consists of a cylinder bore with a priming or pumping piston and a secondary or metering piston the position of which in the bore is adjustable relative to the outlet port, thus allowing the acceptance volume between the pistons to be varied.

In operation, the priming piston is driven up by whatever driving means is used. The first part of the movement seals off the inlet port and traps a volume of oil, the piston continues to move upwards with the trapped oil moving the secondary piston until it eventually uncovers the outlet port and allows the oil to pass into the outlet to the sight feed tube. The secondary piston is spring loaded and it is urged into contact with the primary piston as soon as the oil is discharged. On the return stroke the two pistons travel downwards, remaining in contact, until the head of the secondary piston abuts on an adjustment sleeve rim and stops, having sealed off the outlet port during the early part of its movement. The primary piston continues to travel downwards until the inlet port is uncovered and the next charge is drawn from the oil reservoir. The volume of oil pumped per stroke can be varied by altering the position of the metering piston in the bore.

The pump assembly in the high pressure stage is of similar arrangement except that the secondary piston is non-adjustable and is located, relative to the outlet port, so that a constant maximum volume of oil is accepted. Also the outlet port communicates with the cylinder bore above the piston so that the piston is hydraulically balanced by the pressure of the set delivery.

Serck Radiators, Ltd.

A composite display showed the range of light heat exchange equipment, produced by Serck Radiators, Ltd., Warwick Road, Birmingham, 11, and was accompanied by other examples of cooling apparatus. One exhibit was a combined heat exchanger and oil cooler, which we illustrate, in which oil is cooled by fresh water which is in turn cooled by sea water. The oil enters the lower chamber and passes through a series of baffles and is cooled by fresh water which passes through a bank of tubes. The fresh water is cooled in a single pass sea water heat exchanger which forms the upper part of the apparatus. It is suitable for a 50 h.p. engine and is subjected to the following test pressures; 15 lb per square inch on the fresh water side, 100 lb per square inch on the oil side and 60 lb per square inch on the sea water side.

Intercooling gives an increase in the power output of a pressure charged engine and an example of the intercoolers manufactured by the company was on view. This consists of a secondary surface fin-tube block within a rectangular casing which fits the air ducting on the engine; water boxes attached to the block distribute the coolant water through the tubes. The casing is made with cast aluminium side plates and the water boxes are of gun metal while the fin-tube elements have a sheet metal side plate, edge-on to the air flow, with fins of copper and solid drawn aluminium brass tubes and steel fins to give added strength.

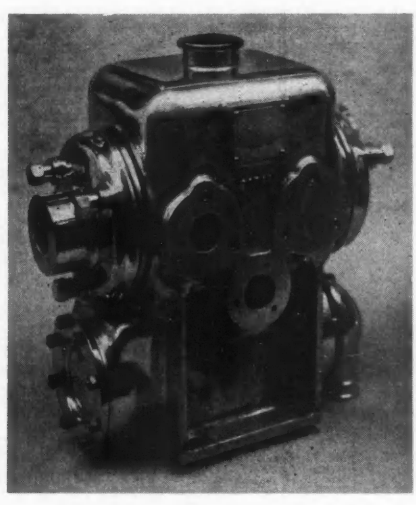


Fig. 36—Single-pass combined heat exchanger and oil cooler—Serck Radiators, Ltd.

ASSOCIATED BRITISH ENGINEERING, LTD.

On the stand of the parent company, Associated British Engineering, Ltd., Henry Meadows, Ltd., Fallings Park, Wolverhampton, showed a number of engines, including the Mark 6.D.M.S. 970 supercharged "Nelson" marine diesel engine, fitted with a M.800 gearbox and capable of developing 214 s.h.p. at 1550 r.p.m. We include an illustration of the engine (Fig. 37) which has been designed for powering tugs, trawlers and ferries, and has six cylinders of 5·9in bore and stroke, a compression ratio of 14·5 to 1, and a weight of approximately 4000 lb. Cast iron is used for the two cylinder block units and the cylinder heads, and the crankcase is of high grade iron. The wet liners are of centrifugally cast high-duty iron alloy. The forged aluminium alloy pistons have three compression and two scraper rings, the connecting-rods are "H" section steel stampings, and the crankshafts runs in seven nitride hardened, preformed, thin-shell-steel-backed bearings, copper-lead-lined and indium treated. Each cylinder has two inlet and two exhaust valves, and the fuel is solidly injected through long stem multi-hole nozzles by a C.A.V. pump. The forced feed lubrication system is served by a gear pump, while a centrifugal pump circulates the fresh water through the cooling system and a heat exchanger incorporating both fresh water and oil cooling elements. Twin 24V 6in axial starters are fitted, and a 24V dynamo; supercharging is by a Brown Boveri exhaust-gas-driven turbo charger directly coupled to the engine.

The 6H.D.T. 970 horizontal diesel engine, which the company has developed for underfloor mounting, was also shown. It is a six-cylinder, in-line, four-stroke, direct-injection, cold-starting, water-cooled engine having a bore and stroke of 150mm. The specification is similar, and many parts are interchangeable with the vertical engine of the same capacity, and the engine, which is easy to install and has an economical fuel consumption, develops 165 b.h.p. at 1800 r.p.m.

On the same stand, H. Widdop and Co., Ltd., Greengate, Keighley, showed a Mark G.M.B.5 two-stroke diesel engine which develops 550 b.h.p. at 300 r.p.m., and has a consumption of 0·36 lb/b.h.p./hour, and is representative of the engines built by the company, which range in power from 400 b.h.p. to 880 b.h.p. Air for the scavenging system is supplied by a double acting constant-air-flow piston pump, mounted integrally with the engine, and with its cylinders arranged in vee form. The bedplate is a rigid iron casting, the crankcase is a massive casting, the cylinders are individual castings of close grained grey iron, and the cylinder heads are simple castings having ample cooling water spaces. Special wear resisting iron is used for the pistons, which are cooled from the oil lubricating system, the connecting-rods are machined steel forgings and the crankshaft is machined from a single piece steel forging and carried in white metal bearings. Separate fuel pumps, each with a hand operated priming lever, is fitted to each cylinder. The main oil system operates on the dry sump principle, and two pumps supply oil under pressure to all bearings and drives. There are two gear-driven plunger pumps; one circulates sea-water around the engine and the other is for bilge and general service duties. A centrifugal governor controls the engine speed and starting air is provided by a gear-driven water-cooled compressor fitted integrally with the engine.

The Bergius Company, Ltd., 254, Dobbies Loan, Glasgow, C.4, exhibited three engines, "K.R.6.," a six-cylinder, four-cycle, solid injection diesel engine developing 132 h.p. at 750 r.p.m., the "E.4," a four-cylinder petrol paraffin engine developing 15 h.p. at 1000 r.p.m. on petrol, and the same power at 1150 r.p.m. on paraffin, and the "J.4," hand starting salt-water-cooled diesel engine. This latter engine, which is illustrated in Fig. 38, has four cylinders of 4½in bore by 6⅝in stroke, and develops 11 b.h.p. per cylinder at 1000 r.p.m. The cylinders, which have detachable heads, renewable valve guides and hardened liners, are monobloc castings. Access doors are fitted on each side of the one-piece crankcase, and the heat treated alloy steel crankshaft has hollow crankpins and has a bearing between each cylinder and two between the front cylinder and flywheel. Lubrication is automatic and the system is supplied by a ram pump, and the reverse gear is attached directly to the engine.

DRYSDALE AND CO., LTD.

The selection of land and marine pumps shown by Drysdale and Co., Ltd., Bon Accord Works, Yoker, Glasgow, W.4, included a single stage "Rotary-Centrex" unit which can be seen in Fig. 39.

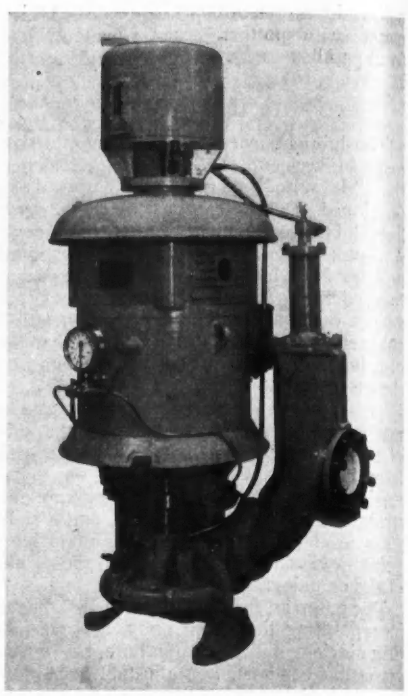


Fig. 39—Single stage "Rotary Centrex" pump—Drysdale

This is a "2/2½ size" pump driven at speeds ranging from 1500 to 1800 r.p.m. by a 4·5/5·5 b.h.p., d.c. electric motor and having a capacity of 10/20 tons per hour against a head of 80ft. The pump shown is the smallest of such units, the largest being the 9/12 pump capable of delivering 450/750 tons per hour against a head of 120/80ft. When pumping bilges the pump has to deal with a mixture of air and water, and in the pump the air is separated from the water and rises to the top of the suction chamber from which it is withdrawn by the air pump through a float-operated valve. This is shut, when the water fills the suction chamber, by the action of the float so that no water or solid matter can enter the air pump. By this system of separating air from water the full rated output of water is maintained with air present up to the capacity of the air pump.

The pump casing can be of either gunmetal or cast iron, with renewable impeller clearance rings of leaded bronze, and is of divided

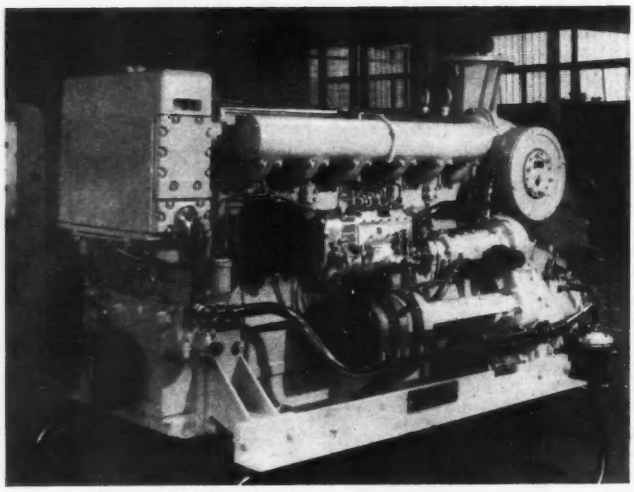


Fig. 37—Supercharged "Nelson" oil engine for powering tugs, trawlers or ferries—Henry Meadows

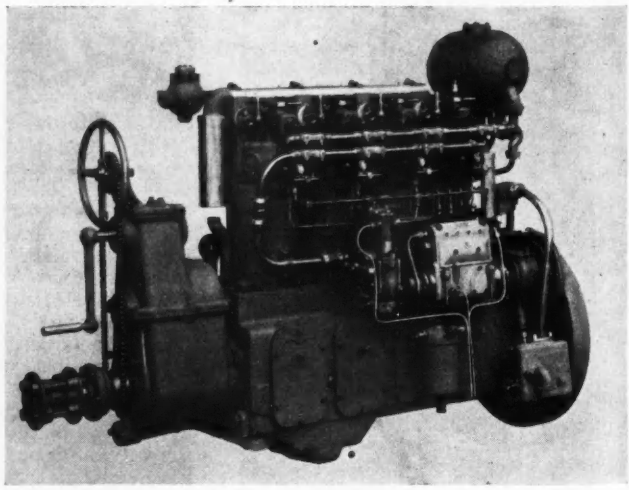


Fig. 38—Hand-starting salt-water-cooled diesel marine engine—Bergius

design with suction and discharge branches in the rear portion so that the impeller and shaft can be removed without breaking pipe joints. The impeller is of bronze. The shaft has a large diameter, and the motor is a vertical shaft enclosed-ventilated drip proof machine having roller journal bearings and a double thrust ball bearing to take any unbalanced thrust, and the weight of the rotating parts. The water-ring air pump has a gunmetal casing and the motor and air pump shafts are rigidly coupled. It has a bronze rotor. A fresh water storage chamber supplies the sealing medium for the air pump, the sealing water being cooled by the liquid handled by the centrifugal pump.

THE BRITISH ALUMINIUM COMPANY, LTD.

Marine and industrial applications of the aluminium alloys were demonstrated by the British Aluminium Company, Ltd., Norfolk House, St. James's Square, London, S.W.1. One piece of equipment which was shown and is intended for use in an atomic plant has a weight of about 1¼ tons and is largely prefabricated of plate, to specification NP5/6. The plate material which is up to 1⅜in thick has been welded by the self-adjusting arc process. A fuel tank typical of those fitted in coastal minesweepers was exhibited; it was constructed of ¼in plate welded by the "Argonaut" process. Another marine exhibit was a barge rudder having external stiffening and fabricated from ½in thick plate and channel sections. The strength of welding as a method of jointing was directly compared with riveting in a test piece, incorporating both methods of joining, in which, under tensile loading, the riveted joint had failed while the weld had remained intact. A plate ½in thick and measuring 30ft in length by 6ft wide demonstrated the capacity of the company's rolling mills.

DOBBIE MCINNES, LTD.

Examples of the range of instruments which that firm manufactures was exhibited by Dobbie McInnes, Ltd., 191/3, Broom Loan Road, Glasgow, W.1. They included a recent model of the "Farnboro" electric indicator. For this, the latest equipment consists of a diaphragm pick-up and electronic relay unit, by means of which more accurate diagrams can be obtained, and a low pressure recording unit with which low pressure diagrams of high accuracy can be plotted at a scale of 1in to 1 lb per square inch. A completely new device for the rapid conversion of a "Farnboro" diagram, which is one of pressure on a base of crank angle, to a pressure/volume diagram, was on view. The instrument, known as the "Burstall" indicator diagram converter, is illustrated in Fig. 40. It is claimed to be time-saving and accurate for marine use, and for universities and technical colleges. To carry out the conversion, the "Farnboro" indicator diagram is mounted on an internally illuminated clear "Perspex" drum which is driven by a fractional horse-power motor at a very low speed. It is possible to follow the pressure curve, as the drum revolves, by means of a tracer point manipulated by two knobs on the front of the converter. By means of a crank and connecting-rod, the "Perspex" drum is coupled to a second drum so that this reciprocates to give the volume base of the pressure/volume diagram. In turn, the tracer point is linked to a pen which produces the pressure volume diagram on a sheet of paper attached to the second drum. The crank of the converter can be replaced for engines having different crank/connecting-rod ratios.

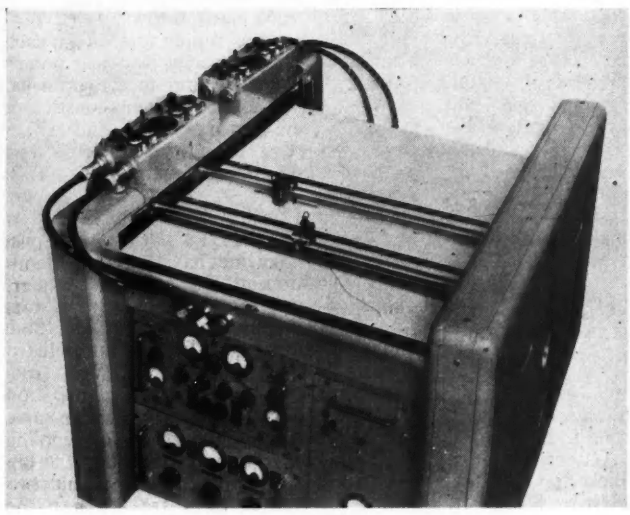


Fig. 41—Electronic plotting table—Dobbie McInnes

The medium-speed plotting table, measuring about 50in in length by 46in wide by 38in high, which was on view, is shown in Fig. 41; it was originally developed for recording input quantities in terms of rectangular co-ordinates, x and y, on a plotting area measuring 30in by 18in. Modifications have been made to the earlier instrument and in the present model it is now possible to apply up to four variables, instead of two, to a recording surface of 30in by 30in. The plotting of four variables can take the form of three independent y motions against a common x motion or alternatively x_1 can be plotted against y_1 and x_2 against y_2. An example of this latter application is the plotting of the path of a target and the path of an interceptor on the same sheet of paper. The plotting table is self-contained for 50 c/s mains.

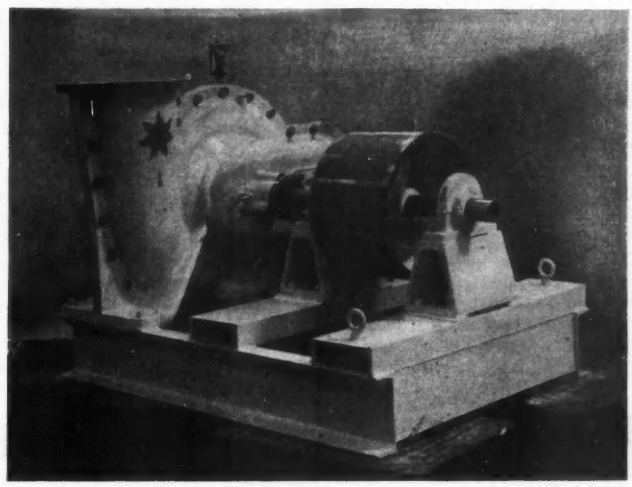


Fig. 42—14in, 5000 gallons per minute "Star" pump—Gwynnes Pumps, Ltd.

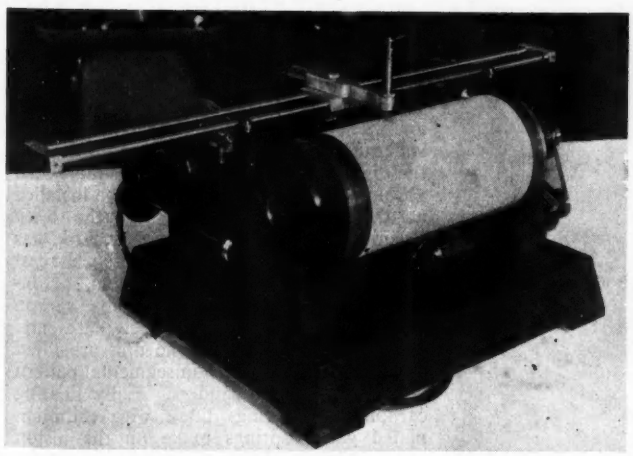


Fig. 40—Back view of "Burstall" indicator diagram converter showing derived pressure/volume diagram—Dobbie McInnes

Among the standard range of engine indicators, such as the normal piston instrument, there was the peak pressure indicator which automatically registers the maximum pressure in the cylinder of a diesel or internal combustion engine, and a type "F" diesel indicator valve which is of stainless steel throughout and does not involve the use of packing.

GWYNNES PUMPS, LTD.

Gwynnes Pumps, Ltd., Hammersmith, London, W.6, exhibited from the standard range of its products, which include sewage pumps, split casing water pumps and multi-stage pressure pumps, but a number of more novel exhibits were also to be seen on the company's stand. These included a 16in vertical spindle sewage pump designed to handle 5600 gallons per minute of sewage against a head of 30ft, a 12in horizontal split casing unit rated at 4000 gallons per minute of water against a head of 40ft, and a 2in vertical spindle pump which has been specially designed for use in power stations to dispose of ash sump drainage water and which can handle 50/80 gallons per minute of drainage water against a head of 40/60ft.

A 14in horizontal " star " pump, illustrated in Fig. 42, was also shown. This pump is pulley driven and specially designed for irrigation; it can discharge 5000 gallons per minute of water against a head of 30/50ft. The pump has a close-grained cast iron casing in halves with a vertical joint, and is arranged with side suction and vertical delivery. A cast iron, double entry, shrouded impeller, hydraulically and dynamically balanced, is fitted and the high tensile steel shaft is carried in two inner gunmetal bearings and two outer Cooper roller bearings. A cast iron gland having ample packing depth is fitted and the bedplate is of fabricated steel.

The Brush Group, Ltd

Engines manufactured by The National Gas and Oil Engine Company, Ltd., Ashton-under-Lyne, J. and H. McLaren, Ltd., Airedale Works, Leeds, Petters, Ltd., Causeway Works, Middlesex, and Mirrlees, Bickerton and Day, Ltd., Mirrlees Works, Hazel Grove, Stockport, were exhibited on the stand of The Brush Group, Ltd. One of these was the Mirrlees Mark " KSSD.M.8 " direct reversing, turbo-charged, intercooled, eight-cylinder-in-line, four-stroke diesel engine, as shown in Fig. 43; it develops 1296 s.h.p. at 300 r.p.m. The turbo-charger is a single stage axial-flow exhaust-gas-driven turbine driving a centrifugal air compressor. The bore and stroke are 15in and 18in respectively and the compression ratio is 12·4 to 1 and compression pressure 455 lb per square inch, while the mechanical efficiency is 85 per cent. The one piece bedplate is of cast iron with engine bearings of box section and the column supports the cast iron cylinder casing which carries the close grained cast iron liners. Two inlet and two exhaust valves are fitted in the cast iron cylinder head in addition to an automatic air starting valve, cylinder relief valve, and fuel injection valve. Three pressure and two oil scraper rings are fitted to the oil cooled pistons and the crankshaft, which is machined from a solid steel forging is carried in white-metal-lined steel shell bearings placed on each side of each crank throw.

Individual pumps supply fuel oil to each cylinder and large capacity twin gear pumps provide forced lubrication to the principal bearings. The cooling system consists of a fresh water primary circuit and a sea water secondary circuit, there being one double acting plunger pump for each system.

Among the smaller engines was the Petter-McLaren model PDV8 air-cooled, four-stroke, diesel engine having a continuous rating of 96 b.h.p. at 1800 r.p.m. The cylinders which have a bore of 114·3mm by 110mm stroke and a compression ratio of 16 to 1, are arranged in two banks of four with an included angle of 90 deg. The well ribbed cast iron crankcase carries separate cast iron cylinders having separate heads of the same material, which are finned for cooling purposes. Three compression rings, the top one of which is chromium plated, and two slotted oil control rings are fitted to the aluminium pistons and the " H " section forged steel connecting rods have thin-shell steel-backed, copper-lead-lined big end bearings and small end bushes of phosphor bronze. Two block pumps arranged in tandem deliver fuel to the cylinders through multi-hole injectors and a gear pump delivers lubricating oil under pressure to the principal bearings. For cooling purposes each cylinder bank is cowled and has its own belt driven axial flow fan.

Gilbert Gilkes and Gordon, Ltd.

Examples of heavy duty self-priming marine pumps were exhibited on the stand of Gilbert Gilkes and Gordon, Ltd., Kendal, Westmorland. The pumps are built in four sizes up to a maximum output of 200 gallons per minute and the single stage pump operates up to a 200ft head while two stage pumps are available up to a 700ft head. One of the exhibits was a Gilkes-Lister independent marine fire fighting pump unit, consisting of a Lister Mark " F.R.2 " diesel engine, one of the "Freedom" range of engines, driving a direct coupled and flange mounted No. 250 G.G.G. pump. The unit can throw two ½in jets 40ft high at 45 deg. and when using one ¾in bore nozzle a jet can be thrown 55ft at an angle of 45 deg. or 85ft horizontally. Fuel is provided for ten hours continuous operation and the unit has a net weight of 1600 lb.

Another exhibit was the " Gilline " hydraulic linehauler which utilises hydraulic motive power to give infinitely variable speed control and to give freedom from damage should the hauler be stalled for any reason. The hauler, which is a heavy duty unit and can be mounted either on a ship's rail or deck pedestal, has a case and covers of close grained cast iron enclosing a No. 6 Gilkes pelton wheel, cast in high tensile bronze and keyed to a 3 per cent nickel chrome steel main shaft. The shaft is carried in two heavy duty deep groove ball journal bearings, protected by double shaft seals, and drives two stainless steel cross shafts, each having phosphor bronze worm wheels. The cross shafts pass through seals in the drive side cover and are fitted with deep grooved chilled face rope drums. Control of the hauler, which has a normal pull of 152 lb and a starting pull of 260 lb, is by a single spade handle, and the quantity of water required for its operation is 38·8 gallons per minute at a pressure of 73 lb per square inch.

Harland and Wolff, Ltd.

Models as well as actual engines demonstrated the many engineering activities of Harland and Wolff, Ltd., Belfast. Marine engines were represented by models of a six-cylinder, two stroke, single-acting, crosshead turbo-pressure-charged opposed piston engine of 10,000 b.h.p. at 120 r.p.m., and an eight-cylinder trunk piston engine developing 6000 b.h.p. at 220 r.p.m. There was a model of a 3200kVA alternator driven by a six-cylinder turbo-charged opposed-piston diesel engine and also of a gas-turbine-driven blower intended for a sewage disposal works, which can deliver 25,000 cubic feet of free air per minute at 7½ lb to 9 lb per square inch.

Typical of the alternator sets built by the company for land and marine purposes was an eight-cylinder, four-stroke, turbo-charged diesel engine coupled to an alternator and exciter and developing 625kVA at 600 r.p.m. Representative of another branch of the engineering range was a Harland and Wolff-Cooper-Bessemer Mark " FM4 " compressor. This is a horizontally-opposed double-acting unit, having four cylinders of 9¾in by 10½in bore and stroke, intended to be driven at 325 r.p.m. through a double reduction gear by a turbine running at 6000 r.p.m. but shown coupled to a Harland and Wolff electric motor of 800 b.h.p. The volumetric efficiency is about 80 per cent and when on normal duty the suction pressure is about 375 lb per square inch absolute and the discharge pressure 592 lb per square inch absolute. The unit, which is to be installed at the Shellhaven refinery of the Shell Refining and Marketing Company, Ltd., has a cast iron frame, and cylinders of special cast iron with shrunk in honed liners. Non-lubricated pistons built from carbon discs sandwiched between steel plates and bolted together to form one unit are fitted and the rings are of carbon segmental pattern fitted with steel expanders. Fully floating carbon sealing rings fitted with cadmium plated garter springs make up the piston rod packing. High tensile steel is used for the piston rods, cast steel for the connecting rods and forged steel for the crankshaft, which is carried in six precision bored white

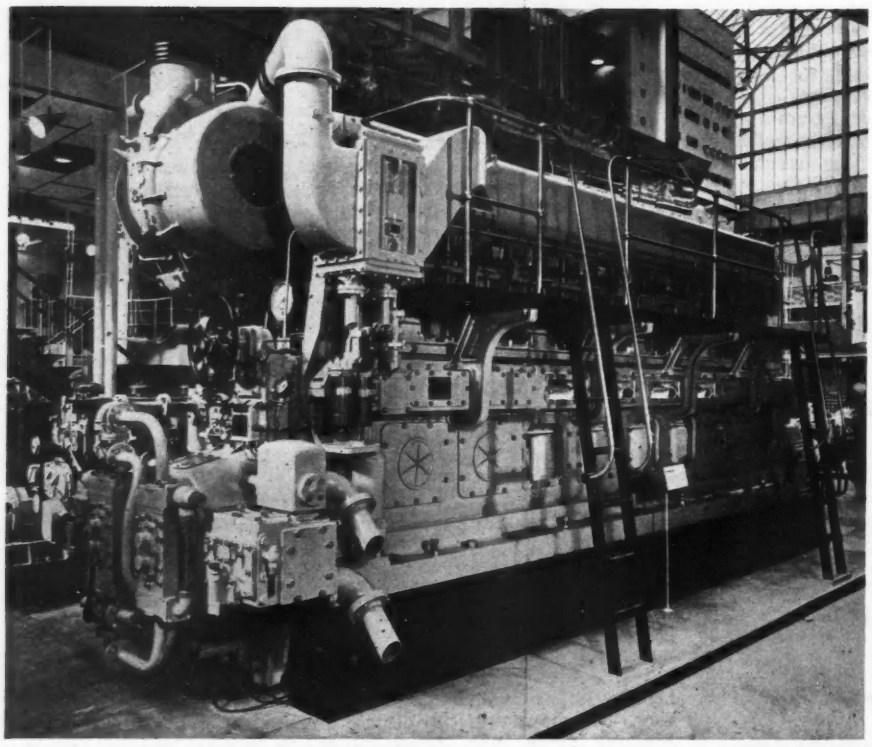


Fig. 43—Pressure-charged, intercooled diesel engine of 1296 s.h.p.—Mirrlees, Bickerton and Day

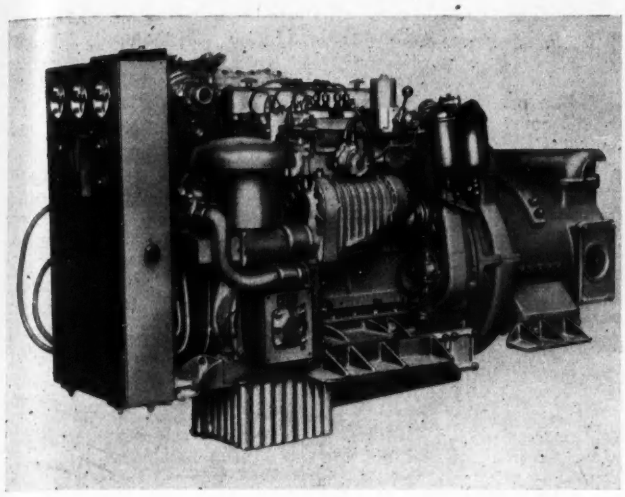


Fig. 44—Lightweight marine generator of 40kW, d.c.—Fodens

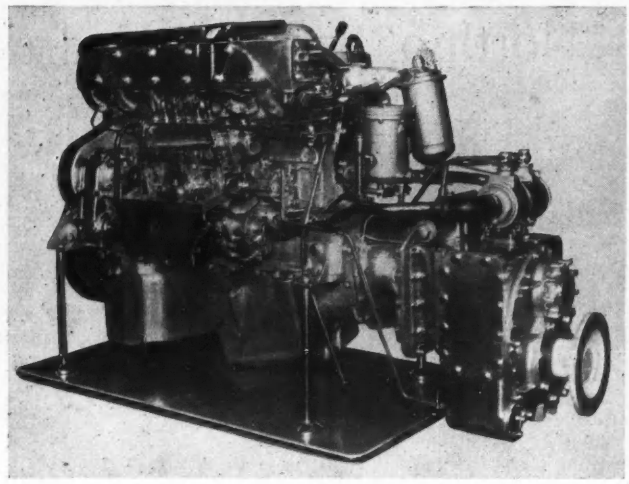


Fig. 45—Diesel engine with 3 to 1 reduction gearbox—Perkins

metal bearings. For service purposes a special extension has been provided on each crosshead so as to form a cofferdam between the crankcase and the compression cylinder so that no part of the piston rod which enters the crankcase also enters the non-lubricated packing.

FODENS, LTD.

A twelve-cylinder marine engine fitted with a Thornycroft reduction gear and rated at 210 b.h.p. at 1800 r.p.m. was shown by Fodens, Ltd., Elworth Works, Sandbach, Cheshire. Also three six-cylinder units were shown, including one fitted with a flange mounted centrifugal pump delivering 500/750 gallons per minute, another forming the power unit of a 60kW self contained generator set and the third being a sectioned engine. Two four-cylinder models were on view, one being an industrial engine and the other being flange coupled to a 40kW lightweight d.c. generator.

The 40kW d.c. lightweight marine generator, seen in our illustration, is powered by a Mark "F.D.4" supercharged uniflow-scavenged two-stroke compression ignition engine in which a Roots blower delivers air to a common air chest and thence to the cylinders through ports. Twin-rocker-operated exhaust valves are located in the cylinder head. The bore and stroke are respectively 85mm and 120mm and the compression ratio 14 to 1. The crankcase and cylinder block form a single aluminium alloy casting fitted with cast iron wet liners and the cylinder head is of high duty iron. Long cast iron pistons are fitted and high tensile forged steel "H" section connecting-rods; the nickel steel crankshaft has five steel-backed white metal bearings. A unit fuel pump and a diaphragm lift pump deliver fuel to injectors having single large hole nozzles and a gear pump provides pressure lubrication.

WADE ENGINEERING, LTD.

A full range of standard blowers, up to 6 litre capacity, was shown by Wade Engineering, Ltd., Crowhurst Road, Brighton 6, Sussex. In addition there was exhibited the company's series 3 blowers which have from ¾ to 2 litres capacity per revolution and have been developed on similar lines to the existing "4R"—3 to 6 litre series. The front and rear housings and covers are of anodised aluminium alloy and the three lobe rotors, which are formed complete with their shaft from a special aluminium extrusion, are cored for lightness and low rotational moment of inertia. A combination of steel and bronze has been used for the helical gearing. Two labyrinth seals and an air gap in the housings form the oil seal and by means of an inlet by-pass, the air gaps can be used for operating fluids other than air. Maximum quietness in operation is achieved by the use of helical ports and the bearing carriers are in steel as is the extension shaft which is rubber cushioned.

F. PERKINS, LTD.

Several Mark "P," "L" and "S" engines were on view on the stand of F. Perkins, Ltd., Peterborough. The industrial group of engines included three, four and six-cylinder models shown with pedestal or bearer mountings, arranged for installation in a tractor, equipped with clutch and gearbox, and in power pack form. For marine applications there were two "L.4(M)" engines, one fitted with Parsons mechanical reverse gear and the other equipped with Slack and Parr variable pitch propeller and stern gear. The "P.6(M)" power unit represented the "P" series of engines and was shown with a "MR.11.B." oil operated reverse gear, while the Mark "S.6.(M)" engine, seen in Fig. 45, was exhibited equipped with a "MRF.10.A." oil operated three to one reduction and reverse gear.

The engine is a six-cylinder in line, four-stroke unit having a bore of 111mm and a stroke of 127mm and developing 75 b.h.p. at 1500 r.p.m. or 100 b.h.p. at 2000 r.p.m. The cylinder block is a one piece casting of nickel chrome cast iron and the cylinder head is a two piece chromium iron casting carrying the tappets and rocker gear. Dry liners are fitted and also aluminium alloy pistons having three pressure and two scraper rings and the crankshaft, forged from nickel chrome molybdenum steel, is supported in bearings on either side of each cylinder. A lift pump and a unit pump deliver fuel to atomisers having two hole nozzles and forced lubrication is used throughout the engine. Direct sea-water cooling is arranged.

CENSUS OF PRODUCTION, 1951.—There has now been published in Volume 3 of the *Report on the Census of Production for* 1951 the tables covering aircraft manufacture and repair. The summaries compare outputs and employments in 1951, 1950, 1949 and 1935; subsequent tables cover the United Kingdom activities, dealing separately with small firms and larger establishments (employing more than ten persons). Tables show the division of sales, employment, &c., between England, Wales and Scotland.

Continental Engineering News

German Productivity in 1954

The Statistical Office of the German Federal Republic reports that overall productivity of the German economy increased by 4 per cent during 1954. The largest increase was in the industrial section, where it amounted to 14·6 per cent. The "productivity increase ratio" has also risen by about 4 per cent. Wages have kept pace, the average monthly wage in 1954 amounting to DM 328, an increase of 4·1 per cent on 1953. One result of the increase in productivity has been the decreased proportion of national income spent on necessities. In 1954 this figure stood at 48·9 per cent, whereas it was 54·7 per cent in 1936.

Economic Developments in Sweden

Recently published statistics show that the total output of electric power in Sweden has increased from 13,500 million kWh in 1945 to 23,700 million kWh by 1954. Government investments in power plant which amounted to Kr. 39,000,000 in the fiscal year 1944–45, rose to Kr. 337 million for 1955–56. Among Sweden's technical contributions in the field of electric power during this period are the world's first 380kV long-distance power line and a submarine high-voltage d.c. cable.

The number of motor-cars rose from 39,100 in January, 1945, to 194,500 in January, 1950, and 535,000 at the beginning of this year. Corresponding figures for commercial vehicles are 38,200, 79,500 and 110,000, respectively. In addition there are to-day some 10,000 buses, 320,000 motor-cycles and 330,000 powered bicycles. Sweden has the largest ratio of cars per head of population in Europe.

The S.A.S. (Scandinavian Airlines System), which was founded in 1946 and consolidated in 1950 through the merger of the national airlines of Sweden, Norway and Denmark, is now the fourth biggest carrier in the world, rising from 307,100 passengers in 1947 to 536,000 in 1954.

During the first half of 1955, forty ships totalling 272,000 tons gross, or 406,000 tons deadweight, were delivered by shipyards belonging to the Association of Swedish Shipyards. New contracts have exceeded those concluded in January-June, 1954, and practically all tonnage delivered has been replaced by new orders, thus assuring work for one and a half to two years ahead. The position is less favourable for the smaller yards. There is also a decrease in the demand for tankers.

According to official statistics, 176 new and old ships, including fifty-five pleasure craft, were delivered to foreign owners in 1954. Their total value was Kr. 592 million (£41,000,000). Sixty-eight were motor vessels, representing a gross tonnage of 426,310 tons and a value of Kr. 547 million, while forty-two were steamers, totalling 81,360 gross tons, and costing nearly Kr. 34,000,000. Thirty-six of the motor vessels were delivered to Norway.

North of Scotland Hydro-Electric Schemes

No. VI—THE TUMMEL-GARRY SCHEME,* PART IV

(*Concluded from page 400, September 16th*)

Our description of the Tummel-Garry hydro-electric development concludes with some details of the construction of the main turbo-alternator sets at Errochty power station, and of the substation nearby. Three similar 25MW sets are installed at Errochty, to give an estimated annual output of 103 million kWh.

IN this concluding article we give some details of the construction of the main turbo-alternator sets at Errochty power station. The sets were briefly referred to last week in Part III, when the electrical and mechanical layout at Errochty was described generally. It will be recalled that there are three identical 25MW sets installed. They are vertical-shaft, direct-coupled machines, designed to generate at 11kV, 0·9 p.f., when driven at 428 r.p.m., the complete sets having a safe overspeed of 810 r.p.m.

The Alternators

The stator frame (Fig. 15) of each alternator is octagonal in shape and is fabricated in two halves, which are bolted and dowelled together. The segmental core stampings are secured by dovetailed keys bolted to longitudinal ribs inside the frame. The winding is a two-layer diamond winding, the connections being brought out through an insulating plate near the bottom of the frame. Class B insulation, consisting of mica and "Micanite," is used throughout. The end windings are protected by aluminium guards which also assist in guiding the cooling air through the machine.

The rotor shaft and coupling are forged in one piece, the rotor body, comprising two forged steel rims, being shrunk on and keyed to a cast steel spider, which, in turn, is keyed to the shaft (Fig. 16). The laminated poles are dovetailed into the body and secured by taper keys. The rotor is supported in the top bracket by a Michell combined thrust and guide bearing, designed to carry a total load of 180 tons. This bearing is insulated from the supporting structure in order to eliminate circulating currents in the rotor shaft. The bottom guide bearing is of the sleeve type.

Exciter Assembly.—The armatures of the main and pilot exciters are mounted on a forged steel shaft which also carries the cupro-nickel alternator sliprings and is solidly coupled to the alternator shaft. The main exciter is separately excited while the pilot exciter, which is compound wound, is provided with a shunt field regulator for initial adjustment of its field current. The permanent magnet alternator for supplying power to the turbine governor motors is flexibly coupled to the exciter shaft, and above this are mounted the speed-limiting device and tachometer. Since the exciters are enclosed, bulkhead lighting fittings are provided to illuminate the interior of the housings so that the commutators, sliprings and brushgear can be observed through inspection windows. There is a raised platform round the exciter assembly and there are doors in the housings.

Ventilation.—The cooling system forms a closed air circuit, cool air being drawn from the alternator pit and forced through the machine by two centrifugal fans, one at each end of the rotor, and returned to the pit through the cooler. Cooling air for the exciters is diverted from the main supply, circulated through ducts, and returned to the pit through two sections of the cooler.

The closed-air-circuit cooler comprises eight self-contained, water-cooled sections mounted around the shell of the machine, as shown in Fig. 17. The capacity of each section is such that any seven sections are capable of dissipating the full-load losses, so that any one section can be isolated for maintenance while the machine is at full speed.

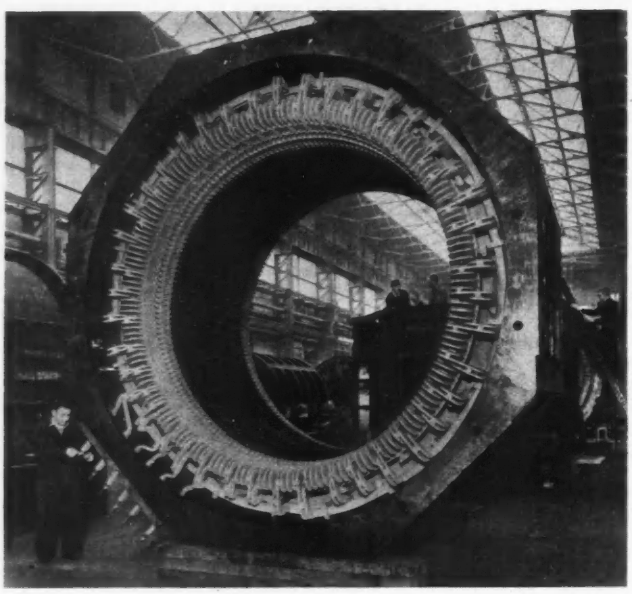
Six of the sections have a capacity of 7260 cubic feet of air per minute, the other two having a capacity of 8220 cubic feet per minute. The two larger ones allow for the air flowing from the exciters through the ducting. Four of the remaining six sections are fitted with dampers for air to be by-passed into the station, while the other two are used purely for cooling the air from the alternator.

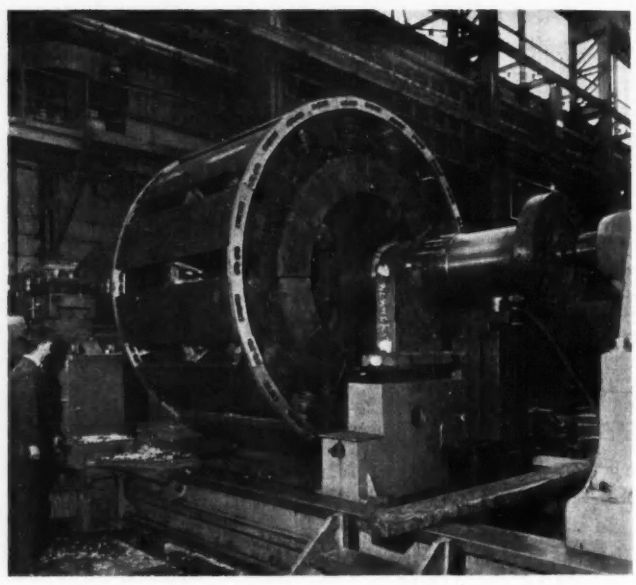
The cooling water, from the tail-race is fed to the coolers from a ring water main at the top of the alternator pit. With a water inlet temperature of 18 deg. Cent. and a rate of flow of 616 gallons per minute, the complete cooler will reduce 60,000 cubic feet of air per minute from a temperature of 50 deg. to 27 deg. Cent.

Lubrication.—The alternator guide and thrust bearings are arranged for flow lubrication, oil from a 650-gallon tank being circulated by a pump with a capacity of 78 gallons per minute at 100 lb per square inch pressure. This pump is driven by an 11 h.p., 415V, 2900 r.p.m., squirrel-cage motor. A similar standby pump, the driving motor of which is fed from an independent source, is automatically brought into operation if the rate of oil flow falls below a given value. The oil circuit includes a strainer and an oil cooler capable of dissipating 18,000 B.Th.U. per minute, and designed to handle 165 gallons of oil per minute. A standby cooler is provided to allow for servicing while the set is in operation.

Braking and Jacking System.—The braking and jacking equipment, which is illustrated in Fig. 18 on page 436, comprises six rams, equally spaced and acting upon a brake ring secured to the base of the rotor, the top of each ram forming a flat plate which carries a heavy brake lining. Although the braking and jacking systems are linked, they are operated independently.

In the braking system, oil is forced from the reservoir by air fed into the top at a pressure of 100 lb per square inch. Air at





Figs. 15 and 16—Final stages in the manufacture of an alternator for Errochty power station. Fig. 15 (left) shows the completed stator and Fig. 16 (right) the final machining of the rotor shaft. The alternator is of 25MW nominal capacity

* No. I : "An Introductory Survey," appeared July 14, 1950 ; No. II : "The Loch Sloy Project," July 21-August 4, 1950 ; No. III : "The Fannich Project," June 8–15, 1951 ; No. IV : "The Mullardoch-Fasnakyle-Affric Project," April 11–25, 1952 ; No. V : "Some Schemes for Local Supply," October 16–23, 1953.

this pressure is produced by a compressor, a single machine performing this duty for all three alternators ; there is, however, an auxiliary pump which can be used if the compressor breaks down. The oil passes from the reservoir, through a strainer and a non-return valve, to the circle of cylinders, forcing the rams upwards against the brake ring. This action provides a braking torque which is capable of stopping the rotor in about two and a half minutes. The brakes cannot normally be applied until a rotor speed below normal is reached. Due to the low pressure of air in the reservoir, the force applied to the rams by this system is insufficient to lift the rotor.

The jacking system is provided to lift the rotor, when at standstill, to allow an unrestricted flow of oil through the thrust bearing pads before starting after a prolonged shut-down, and also to allow maintenance to be carried out. Oil is fed direct to the cylinders at a pressure of 1500 lb per square inch by a high-speed multi-ram pump. Limit switches on the cylinders restrict the upward travel of the rams and ensure that each one rises to exactly the same height. If these switches should fail, mechanical stops come into operation and, in this case, the excess oil supplied by the pump is returned to the supply tank through the high-pressure, solenoid-operated relief valve. Electrical interlocks ensure that the machine can be started only when all rams are in the fully lowered position. Hand-operated sustaining screws are provided to support the rotor in the elevated position, mechanical locking gear being incorporated to prevent these devices from being raised or lowered until the rams have been elevated. This arrangement also prevents the screws from being engaged when the rams are being used for braking, as it is necessary to lift the rotor slightly, even with fully worn brake linings, before the locks are cleared.

The Turbines

The Francis turbines are, in the main, of standard design. The runner, in each case, is a single-piece stainless steel casting having a nominal diameter of 6ft and is solidly coupled to the turbine shaft which is guided, at its lower end, by a white-metal-lined sleeve bearing lubricated with oil obtained from the alternator lubrication system. Flow through the runner is controlled, as normally, by the movement of the guide vanes, and each vane is connected by a lever and link to the regulating ring. The movements of this ring are dictated by the main servomotor, which is controlled by the turbine governor, arrangements being made to lock the guide apparatus when the vanes are in the fully closed position.

Each set has a 5ft 6in diameter main inlet valve between the end of the penstock and the turbine inlet, with a bypass sluice valve. The inlet valve is a rotary valve, its position was shown in Fig. 12 of last week's issue. Both valves are hydraulically operated and are controlled by a solenoid-operated combined by-pass operating valve and main pilot valve. Limit switches, for interlocking and indicating, are fitted at each end of the main valve travel.

Control Gear

As already stated, three alternative methods of control are available. The station may be operated automatically either by remote control from the group control centre or by local control from the station itself, and facilities for local manual control are also provided. The method of operation to be employed is selected by " auto/manual " and " local auto/remote auto " control selector switches.

The main electrical control gear for each set is housed in a turbine suite and field suite, mounted on the main turbine room floor adjacent to the associated generator (see Fig. 12 *ante*), and in a unit board. The latter is installed, together with a generator junction cubicle in which the main control connections are marshalled, in the alternator chamber on the floor below.

The centre from which the station is operated under local automatic control is the turbine suite, the turbine panel of which incorporates all the controllers, meters, gauges and thermometers required for this purpose, together with a comprehensive system of indicators and alarms. In addition, the majority of the associated relays and contactors, including interposing relays through which remote control is effected, are mounted in the turbine contactor panel of this suite. The field suite houses the automatic voltage regulator with the whole of its associated equipment. Starters for the motors driving

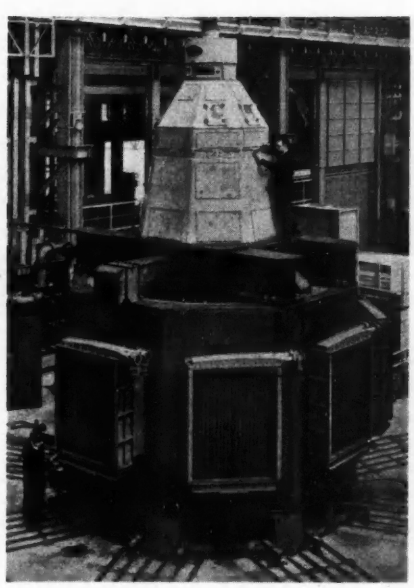


Fig. 17—A works test of an alternator for Errochty power station is here shown in progress. The cooler sections are clearly visible

the governor oil pump, bearing oil pump and cooling water pump are mounted in the unit board, the 415V, 3-phase supplies being drawn from the corresponding unit transformer. The standby bearing oil pump motor is also controlled from the unit board, but its starter is connected to the common services board, the supply to which is independent of the unit transformer so that the pump can be operated even when none of the sets is running. In addition to the equipment already mentioned, separate wall-mounted starters are provided for the remaining auxiliary drive motors, these also being supplied from the common services board.

Overall Controls.—Once the field switch has been closed, the operation of each set is under the overall control of a master control relay, housed in the turbine contactor panel. When the selector switches mounted on the turbine panel are set to the manual position, this relay is energised by a limit switch as soon as the guide vanes are unlocked. Under local automatic control the relay is closed by the " start " push button, and under remote control by contacts on an interposing relay. Contacts on the master relay control the energising of " start " and " stop " bus wires and thereby the automatic operation of the complete set.

Emergency shut-down is initiated either by the turbine shut-down relay, which operates under certain alarm conditions, or by a timer which is arranged to operate if the time taken to bring the generator up to speed with all auxiliaries operating correctly should exceed a predetermined value.

Main Inlet Valve Control.—Manual control of the main inlet valve is effected by a controller on the turbine panel, while under automatic control the valve is opened or closed by energising the " start " or " stop " bus wire respectively. A limit switch on the guide vane lock is connected in series with the valve-opening solenoid and prevents the valve from being opened under either manual or automatic control unless the vanes are locked. A similar device ensures that the valve can only be closed automatically when the guide vanes are closed. Closure of the valve may also be prevented, either locally from the turbine panel or remotely from the group control centre, by a lockout relay, but in an emergency operation of the turbine shut-down relay will close the valve under either control and independently of the lockout.

As soon as the inlet valve begins to open a time delay relay is energised. If the valve functions normally the relay is de-energised at the fully open position, but if for any reason the time required for the complete travel is excessive the relay operates to isolate the valve control solenoids from all automatic control, thus ensuring that any further movement of the valve is the result of a deliberate manual action.

Guide Vane Control.—The " start " and " stop " push buttons by which the guide vanes are operated under manual control are mounted on the actuator, automatic operation once again being dependent on the energising of the " start " and " stop " bus wires. A system of limit switch and relay interlocks ensures that before the vanes can be opened the rotor jacks must be fully lowered with the sustaining screws withdrawn, the load limiter must be in the fully closed position and the inlet oil to the main servomotor must be at its normal pressure. Under automatic control it is further ensured that an adequate supply of lubricating oil is flowing to the bearings, that the main inlet valve is open before the guide vanes are opened, and that the actuator is in the closed position before the vanes can be closed. The shut-down relay, however, as in the case of the main inlet valve, exercises overriding control.

A meter on the turbine panel is energised by an auxiliary relay to record the time that the guide vanes are open.

Jacking and Braking Control.—The control circuits for the jacking and braking equipment are so arranged that neither operation can be carried out unless either the guide vanes are locked or the main inlet valve is closed. In addition, an interlock on the master control relay ensures that the starting sequence has not been initiated.

The jacking operation can only be performed under manual control from the turbine panel. Movement of the controller to the " raise " position energises a motor which closes the regulating valve on the jacking gear. Immediately the valve is closed the jacking pump starts automatically and raises the jacks until, at the fully raised position, a limit switch operates to cut out the jacking pump motor. Alternatively, the pump may be stopped in any jacking position by means of a switch on the turbine panel. When the controller is set to " lower, " the regulating valve is driven to a " restricted

open" position so that the rotor is lowered gradually until it rests on the thrust bearing, thus relieving the fluid pressure in the system. As a result contacts on the pressure gauge operate to energise the driving motor of the regulating valve which moves to the fully open position.

The brakes are applied by admitting compressed air, through the brake valve, to the oil reservoir, which is closed to atmosphere by another valve. Under manual control from the turbine panel, movement of the controller to the "on" position closes the atmospheric valve, after which contacts on the tachometer operate as soon as the machine is running at less than 50 per cent of the normal speed, closing the jacking regulating valve and opening the brake valve so that the brakes are applied. Under automatic control, the brake valve solenoid is energised by an auxiliary stopping relay. If the turbine shut-down relay operates, the brakes are applied as long as the set is running at less than 107·5 per cent normal speed. The brakes may be released manually by the controller or automatically by a time delay relay which operates after the brakes have been applied for a preset time of up to five minutes. After emergency braking, the shut-down relay must be reset. Either of these operations closes the brake valve and opens the jacking regulating valve, first to the restricted and then to the fully open position.

Excitation.—The field switch is hand-operated, but is automatically tripped by the operation of the turbine shut-down relay.

Voltage Regulation.—The automatic voltage regulator is essentially a vibrating contact device the moving contacts being vibrated by a motor-driven cam between two adjustable fixed contacts. The position of these fixed contacts relative to the vibrating contacts is controlled by the operating coil. Control of the generated voltage is sectionalised to give coarse and fine regulation, and to provide more precise excitation control when the voltage deviation is in the region of 5 per cent. Facilities are also provided such that the alternator may be run up or shut down automatically under the control of the regulator. Compensation for parallel running is provided by the quadrature droop method, the necessary current compounding being injected into a separate winding on the operating coil. The equipment is also compensated for line drop, the components of the compensating current proportional to the wattful and wattless components of the line drop being summated by a mixing transformer which is common to all three sets.

The operating coil is provided with a frequency-compensated, positive-phase-sequence supply. No-volt protection is afforded by a specially designed relay which discriminates between low voltage due to a system fault and low voltage due to a failure of the control circuit, thus preventing forcing of the excitation if the reference voltage should fail. Power for the regulator operating equipment is normally supplied from the station battery, but the connections are automatically transferred to the pilot exciter when the set is running and synchronised.

The generated voltage may be adjusted independently of the automatic regulator by direct control of the driving motor of the exciter field rheostat, either locally by a controller on the field suite, or remotely from the group control centre by an interposing relay.

Speeder Motor Control.—The driving motor for the speeder gear on the actuator can be operated under either manual or local automatic control from the turbine panel, or, alternatively, under remote automatic control through an interposing relay. Under all control conditions, the motor circuit is broken by limit switches at the maximum and minimum settings.

Load Limiter Motor Control.—The motor drive for the load limiter is used only under automatic control. When it is desired to raise the load, the motor is energised from the "start" bus wire provided that the guide vanes are unlocked. The limiter is then driven until it reaches the fully open position at which point the circuit is broken by a limit switch. The supply for lowering the load is taken from the "stop" bus wire, and a further limit switch operates when the load limiter is fully closed.

Motor-Driven Pump Controls.—As already stated, the main pumps for governor oil, bearing oil and cooling water are controlled by starters housed in the unit board. The latching contactors are operated with "start" and "stop" push buttons, an emergency "stop" button being mounted near each motor. Since these machines are supplied from the unit transformer, they cannot be used during the starting-up period and, therefore, the standby pumps are used at this time.

The standby bearing oil pump motor, as explained earlier, while supplied from the common services board, is controlled from the unit board, normally through the medium of the "start" bus wire. Manual control from the turbine panel is possible for testing. Under all conditions, the contactor operates under the control of a flow relay which starts the pump as soon as the flow falls below 4500 gallons per hour. The standby cooling water pump can be operated under the control of push buttons on a wall-mounted starter or automatically by the unit no-voltage relay on any one of the three sets as determined by a selector switch on the starter.

The driving motors for the dewatering and drainage pumps are both provided with wall-mounted starters and emergency trip buttons, but the drainage pump can also be operated automatically by a relay controlled from two electrodes, one mounted at high-water and the other at low-water level in the drainage sump. The brake air compressor motor can also be operated from its own starter or automatically under the control of a pressure switch.

Indicators and Alarms.—A comprehensive system of indicators, comprising lamps and flag relays, is provided both at the station and at the group control centre. Local indication is given only under manual or local automatic control, the supply to the indicating bus wire being disconnected when remote control is being employed.

Each set is provided with two ten-way alarm units fed through alarm fuses, an indicating lamp being automatically illuminated if one of these fuses should blow. Each unit consists of telephone and flag indication relays, which are energised by various alarm contacts. Under manual and local automatic control, these units actuate an alarm bell and also a beacon lamp on the turbine panel of the set concerned, and for certain selected conditions repeat alarms are initiated at the group control centre.

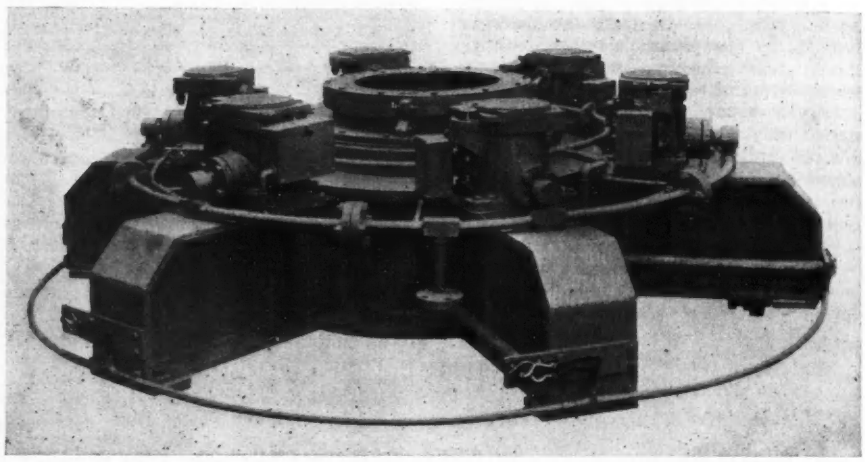


Fig. 18—Alternator braking and jacking system. The plate at the top of each of the six rams acts against a brake ring on the base of the rotor. The braking and jacking systems are operated independently

Errochty 132kV Switching Station

The 132kV switching station at Errochty was briefly mentioned last week, when the way it controls the power generation of the Tummel Valley stations of Rannoch, Tummel bridge, Errochty, Clunie and Pitlochry was explained. The station comprises thirteen circuits controlling one D.C.2* line to Clunie power station; one D.C.2 line to Tummel and Rannoch power stations; one D.C.2 line to Abernethy; one D.C.2 line to Bonnybridge; one D.C.1 line to Killin/Sloy; one D.C.1 line to Fort Augustus; and three 132kV cable circuits to Errochty power station.

The station consists of two single busbars, section coupled, and is so constructed that all circuits occupy their own separate bays, which facilitates complete selection of the busbars to which any circuit shall be connected irrespective of the physical order of entry into the station. This feature also permits the station bay to be converted easily to a double busbar with bus coupler.

The station comprises large bulk oil circuit breakers, "type OW409WN," fitted with self-compensating arc control pots. The operating mechanisms are conventional solenoid-operated, for which a 110V station battery exists in the nearby plant buildings. All the 132kV overhead lines are, or will shortly be, protected by high-speed lock-in carrier current protection. It is worth noting that all supplies required for operating these protective equipments are derived from batteries specially provided to ensure safe and reliable operation even with the complete loss of all auxiliary supplies.

The whole station has been built of concrete and stone, including all high and low structures for supporting the hand-operated

* D.C.2 is a double-circuit line, with both circuits strung on the towers. D.C.1 is a double-circuit line with only one circuit strung, but provisions for the second, when required.

ganged busbar and line isolators, supporting insulators for the busbars and connections. The nearby buildings are in two sections, one consisting of various rooms containing batteries, oil purification plant, relay equipment and auxiliary a.c. and d.c. services. The second building contains the Board's group control centre for the Tummel Valley group, which has already been described. The control room contains a combined miniature control board, which also includes the control of the 132kV switching station.

The three 132kV cable circuits to the Errochty power station replace, on the grounds of amenity, the more usual overhead connections. The cables, together with a number of control cables, cross the River Tummel on a steel bridge, which can also be used in an emergency as a footbridge by the Board's personnel.

The consulting engineers responsible to the North of Scotland Hydro-Electric Board for the whole of the Tummel-Garry scheme are Sir Alexander Gibb and Partners and Messrs. Merz and MacLellan, these two firms concerning themselves respectively with the civil engineering aspects and with the mechanical and electrical aspects of the scheme. The architects are Messrs. Tarbolton and Ochterlony. Messrs. Kennedy and Donkin are the consultants for Errochty substation and the 132kV lines. The principal contractors are listed herewith :

Errochty Section.—Main civil engineering contractor, A. M. Carmichael, Ltd. ; grouting, Cementation Company, Ltd.; tunnel steel lining and power station steelwork, P. and W. MacLellan, Ltd.; gates and screens, Glenfield and Kennedy, Ltd.; power station masonry, Rae, Ltd.

Errochty Power Station.—Turbines designed by Boving and Co., Ltd., and manufactured by John Brown and Co., Ltd. ; governors, John Brown and Co., Ltd.; inlet valves, Glenfield and Kennedy, Ltd.; water pumps, Pulsometer Engineering Company, Ltd.; oil pumps, Mirrlees (Engineers), Ltd.; alternators and exciters, General Electric Company, Ltd.; turbine house crane, Sir William Arrol and Co., Ltd.; step-up and auxiliary transformers, Bruce Peebles and Co., Ltd.; auxiliary switchgear, the British Thomson-Houston Company, Ltd.; 11kV and auxiliary cables, Scottish Cables, Ltd.; lighting and heating, Malcolm and Allan, Ltd.; 132kV switchgear, the British Thomson-Houston Company, Ltd.; 132kV oil-filled cables, the Pirelli-General Cable Works, Ltd.; compensation water turbine, Gilbert Gilkes and Gordon, Ltd.; compensation water alternator, Bruce Peebles and Co., Ltd.; switchgear at Errochty dam, the English Electric Company, Ltd.; lighting, heating and auxiliary cabling at Errochty dam, C. J. Ferguson and Sons, Ltd.

Plant mentioned in the description of the alternators in Part IV was supplied to The General Electric Company, Ltd., by the following firms :—cooler, Premier Cooler and Engineering Company, Ltd. ; lubrication system: oil circulation pump, Mirrlees (Engineers), Ltd., strainer, Auto-Kleen Strainers, Ltd., and cooler, Serck Radiators, Ltd.; braking and jacking equipment, Jones Tate and Co., Ltd.; jacking oil pump, Towler Brothers, Ltd.; automatic voltage regulator, Metropolitan-Vickers Electrical Company, Ltd.

Errochty Group Control Centre.—Control indicating and telemetering equipment, Standard Telephones and Cables, Ltd.; lighting and heating, J. B. Mackenzie (Edinburgh), Ltd.

Errochty Switching Station.—The main contractor for the supply and installation of plant at Errochty substation was the British Thomson-Houston Company, Ltd. The 132kV protection equipment was supplied by the Metropolitan-Vickers Electrical Company, Ltd., and by the Automatic Telephone and Electrical Company, Ltd.

In the earlier works of the scheme at Clunie and Pitlochry the principal civil engineering contractors involved were : William Tawse, Ltd ; the Cementation Company, Ltd.; A. M. Carmichael, Ltd.; George Wimpey and Co., Ltd.; and P. and W. MacLellan, Ltd. Other contractors were :

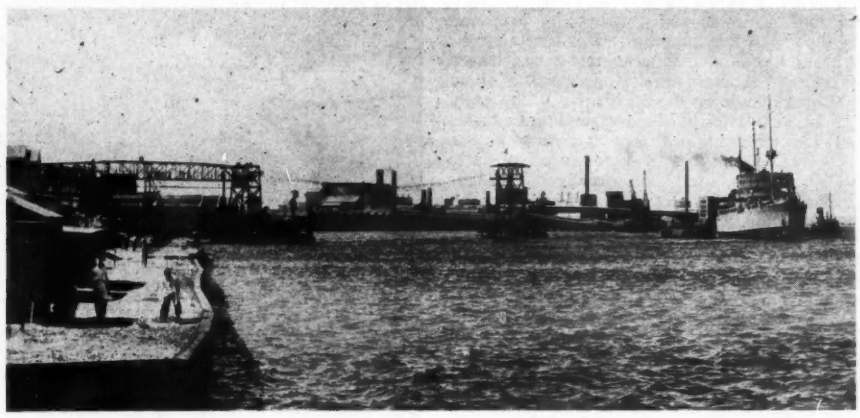
Clunie Power Station.—Turbines designed by Boving and Co., Ltd., and manufactured by John Brown and Co., Ltd.; governors and inlet valves, John Brown and Co., Ltd.; water and oil pumps, Mirrlees, Bickerton and Day, Ltd.; compressors, Westinghouse Brake and Signal Company, Ltd.; alternators and exciters, 11kV auxiliary switchgear, the British Thomson-Houston Company, Ltd.; turbine house crane, Clyde Crane Company, Ltd.; workshop crane, Wharton Crane Company ; main and earthing transformers and busbar reactor, Bruce Peebles and Co., Ltd.; auxiliary transformers, Bonar Long and Co., Ltd.; 11kV cables, British Insulated Callender's Cables, Ltd.; auxiliary cables, Matthew Hall and Co., Ltd.; general indication equipment, Standard Telephones and Cables, Ltd.; compensation water turbine, Gilbert Gilkes and Gordon, Ltd.; compensation water alternator, Bruce Peebles and Co., Ltd.

Pitlochry Power Station.—Turbines designed by Boving and Co., Ltd., and manufactured by Glenfield and Kennedy, Ltd.; governors, Steele and Cowlishaw, Ltd.; water and oil pumps, Mirrlees, Bickerton and Day, Ltd.; compressors, Broom and Wade, Ltd.; alternators and exciters, Metropolitan-Vickers Electrical Company, Ltd.; turbine house crane, Babcock and Wilcox, Ltd.; auxiliary switchgear, the British Thomson-Houston Company, Ltd.; auxiliary transformers, Bonar Long and Co., Ltd.; 11kV cables, British Insulated Callender's Cables, Ltd.; auxiliary cables, Matthew Hall and Co., Ltd.; compensation water turbine, Gilbert Gilkes and Gordon, Ltd.; compensation water alternator, Bruce Peebles and Co., Ltd.

tower through changes in tidal conditions or rocking of the ship. The distance between the wharf and river towers is 260ft and the final span from the river tower to the ship may vary from 200ft to 350ft.

In addition to the hauling device on the wharf tower, there is equipment on the ship to haul the submarine cable along the wire rope spans from which it is suspended at 6ft centres on sheaves. The droop of the catenary formed by the wire ropes requires regulation to ensure that the submarine cable does not come in contact with the river water prior to loading on the ship, that the tension in the wire ropes is kept within safe limits, and that the radius of bending of the cable repeater units does not fall below a specified minimum. The wire ropes can be checked by calibration of the Nylon ropes ; the comparative straightness of the repeater units will be maintained by a rigging of secondary wire ropes slung from the main spans. The design of the river tower was complicated by the fact that the wire ropes may be required to take any line within an angle of 25 deg. on either side of the axis of the gantry, thus allowing for alternative points of entry of the cable into the ships, for different mooring positions of the ships to the dolphins and for three lines of cable to be passed simultaneously.

The gantry was designed and made by Sheppard and Sons, Ltd., of Bridgend, Glamorgan, in collaboration with that firm's consulting engineer, Mr. Clifford E. Saunders. The piling and foundation construction was carried out by John Mowlem and Co., Ltd., with Sir William Halcrow and Partners as consultants.



Submarine telephone cable is loaded on to the cable ship from the gantry shown here. The cable is supported on wire ropes on each side of the river tower. The wharf and river towers are 50ft and 60ft in height respectively

Cable Loading Gantry

For the manufacture of the first Atlantic submarine telephone cables and other similar cables, Submarine Cables, Ltd., has erected and equipped a new factory at Erith, Kent. Cable, on completion of manufacture in the new factory, is conveyed along a gantry to a tank house installation, where it is stored in large steel tanks, pending the arrival of cable-laying vessels. For conveying cable to the cable-laying vessels, a three-span gantry structure has been built. It is illustrated herewith. Next to the tank house, there is a permanent span comprising a steel bridge approximately 175ft long and of tapering width to accommodate the paths of travel of the cable from the two lines of tanks in the tank house. It is of riveted and welded construction, and has rocker bearings at one end. There are then two " demountable " spans to the cable ship.

At the top of the first loading tower on the wharf a bank of vertical sheaves 7ft diameter, and mounted on a horizontal axis, assist in hauling the cable from the tank house to the ship. Small sheaves erected at 6ft centres support the cable above the bridge floor. Between the wharf and the river tower, the cable is to be supported by wire rope. From the second or river tower to the ship the cable is also supported by wire ropes. The wire ropes will be anchored to the ship by a device incorporating a Nylon rope, the elasticity of which will safeguard against any dynamic pull being applied to the river

British Nuclear Energy Conference

The first meeting of the British Nuclear Energy Conference will be held at the Institution of Civil Engineers on Wednesday, November 30th next, and it will be in the form of a lecture symposium. The formation of this organisation by the Institutions of Civil, Mechanical, Electrical and Chemical Engineers and the Institute of Physics was announced in a note in our issue of June 10th last, and this first meeting will be opened by the chairman, Sir Christopher Hinton. In the course of the meeting the following papers will be presented :—" The United Kingdom Atomic Energy Project," by Sir John Cockcroft ; " The Place of Nuclear Energy in United Kingdom Power Development," by Mr. V. A. Pask and Mr. J. C. Duckworth ; " The Use of Research Reactors in Nuclear Power Development," by H. J. Grout, and " Health and Safety in a Nuclear Power Industry," by Mr. A. S. McLean and Mr. W. H. Marley. It is pointed out that, owing to the limited accommodation available, attendance at the symposium will be confined to members of the five participating societies. Those who wish to attend are requested to make early application for tickets to the secretary of the Institution, and there will be no preprints of the lectures.

Production of Copper Tubes

LAST week we had the opportunity to visit the Kirkby Works of Imperial Chemical Industries, Ltd. Immediately after the war I.C.I. gave serious consideration to the possibility of building a new copper tube drawing mill in which plant would embody the advantages of all known techniques and enable them to be developed to a stage hitherto unachieved. The basic requirements were easily stated—to manufacture copper tubes in the longest possible length, employing drawbenches handling a number of tubes simultaneously, and then to draw the tubes on drums by a technique similar to wiredrawing, all the time retaining the full weight of the tube processed from the original casting. It was realised that the limiting factor would be the handling of heavy weights and long lengths of tube between operations. It was eventually decided that, from handling considerations, the longest practical length for a straight drawbench would be 150ft to 170ft and the largest practicable drum diameter 4ft 6in to 5ft. After practical trials it was found that the largest size of tubing which could be drawn on drums of this diameter would weigh 1 lb per foot run. These factors fixed the unit weight of tube processed at 150 lb.

The basic essentials of Kirkby equipment were, therefore, straight drawbenches up to a maximum length of 150ft and drums (known as draw blocks) for drawing to finished size. All drawbenches would draw three tubes at a time, the difficulty of tie-rod stretch being overcome by the use of floating plugs. This would enable drawing speeds of 450ft per minute to be achieved as opposed to maximum drawing speeds of about 100ft per minute on shorter benches. The retention of the full weight of the original tube enabled very long lengths to be drawn on the draw blocks, so it was decided to provide for speeds of up to 1800ft per minute. To overcome handling problems special cranes were devised to enable two, working in tandem, to lift tubes over 100ft long. The final layout included a main mass-production bay in which the 150ft drawbenches would be installed, the most powerful of which would be driven by a 1000 h.p. motor. From the benches the tubes would be coiled and transferred to the draw blocks, and from them to specially designed straightening, cutting-off and coiling equipment to finish tubes to customers' requirements. The problem of small lots in special sizes, which could not be made economically by mass-production methods, was overcome by designing a second bay to which these particular items would be transferred at the point where manufacture departed from the mass-production flow line.

The planning of Kirkby was a major operation, both for the specialist staff of the company and for the many suppliers of equipment who collaborated in producing novel units. Existing machines were work-studied and the performance of the proposed equipment was synthetised. A provisional layout was then reproduced in a complete model of the factory and the effect of operating under various conditions was studied; for example, each movement of each crane was represented by a length of coloured string, and plant was resited or work routes were adjusted to avoid excessive movement. Full-scale wooden models of parts of the major items of equipment were built, and design personnel carried out all the operations necessary on the finished equipment in order to ensure that controls were in the correct position and to discover those factors which might prevent full utilisation of the plant. Films were made of the mock-ups, and they were studied and discussions held with the plant manufacturers.

Having decided on the main characteristics required of the equipment and having studied the most modern equipment to date and the mock-ups of the proposed plant, the actual details of design still presented many difficulties, including the overriding problem of material movement. Floor transport was obviously an impossibility except at the finishing end, and it would be necessary to rely completely on overhead cranes. This meant that the three long drawbenches would have to be installed in line, each with its separate overhead crane or cranes. But to permit transfer of tubes from one bench to another all these cranes would have to be on the same gantry, and this, it was realised, might result in excessive waiting time. So, in conjunction with the machine manufacturers, double loading and discharge mechanisms were designed which eliminated the necessity for complete synchronisation of the overhead cranes and the drawbenches. Similarly, the problem of removing the coils from the draw blocks and supplying new material to them necessitated the design of a special rigid mast crane.

The need for a large number of overhead cranes meant that in each bay there would be approximately six cranes on the main track, which would prevent any one crane moving very far from its own area. It was therefore decided to install a high-speed wall crane to run the full length of the building underneath the overhead cranes on the main track. It was also appreciated that a crane breakdown would seriously interfere with crane movements on the track, so a loft was built in the centre of the main mill into which broken-down cranes could be lifted clear of the main track for repair.

Large-Diameter Tubes

There are few mass-production lines for tubes over 2in in diameter, but the demand for miscellaneous items does, in fact, go up to 20in. As well as providing equipment to make small-bore "oddments," therefore, it was also necessary to design and install plant for the manufacture of relatively small batches of larger tubes, from 2in to 20in in diameter. At the time when the decision was taken to build the Kirkby factory the traditional method of drawing tubes on a steel mandrel, slow and extravagant of labour, was still used for all large-diameter tubes. It was decided, however, that equipment should be provided at Kirkby for the plug drawing of tubes up to 12in in diameter. The needs of the equipment were fundamentally different from those governing the mass production of small-diameter tubes. Because of the small number of tubes required in each batch the incidence of tool change was much greater; indeed, it was more necessary to design machines which enabled tool changing to be effected quickly than to provide high drawing speeds. Drawing speeds were therefore kept low compared with mass-production equipment, but to ensure that the machine could be kept occupied for as long as possible a great deal of attention was paid to the methods of tool change. Special dieheads were designed, and methods were evolved for the rapid supply of tools for the benches.

It was realised that for tubes larger than 12in in diameter the technical advantages still lay with mandrel drawing, but by mechanisation and simplification of operations on the Kirkby hydraulic bench labour utilisation was greatly improved and physical effort much reduced.

Buildings

The design of buildings (Fig. 1) posed special problems for the consulting architect, Sir Percy Thomas, P.P.R.I.B.A., and for the I.C.I. engineers. The layout of machinery, and particularly the need to place the three largest drawbenches end to end, called for a main production unit a third of a mile long; a second overriding requirement was the necessity to avoid ledges and lattice girders which would harbour dust. The design finally adopted for the main production unit comprised an all-welded, double-bay structure, each bay 1530ft long and 90ft wide, with an inside height of a clear 30ft to eaves. To avoid dust traps the Portal frame construction was adopted—a design with the additional advantage of enabling overhead cranes to be housed in the roof space while still retaining the maximum lift required for working. One of the bays accommodates five overhead cranes and one rigid mast crane, the other five overhead and two rigid mast cranes. Both bays are equipped with travelling jibs, each 4 tons on a 15ft arm, which run the full length of the building on each side of the valley and pass underneath the overhead cranes. The gables are designed to carry 5-ton Semi-Goliath cranes.

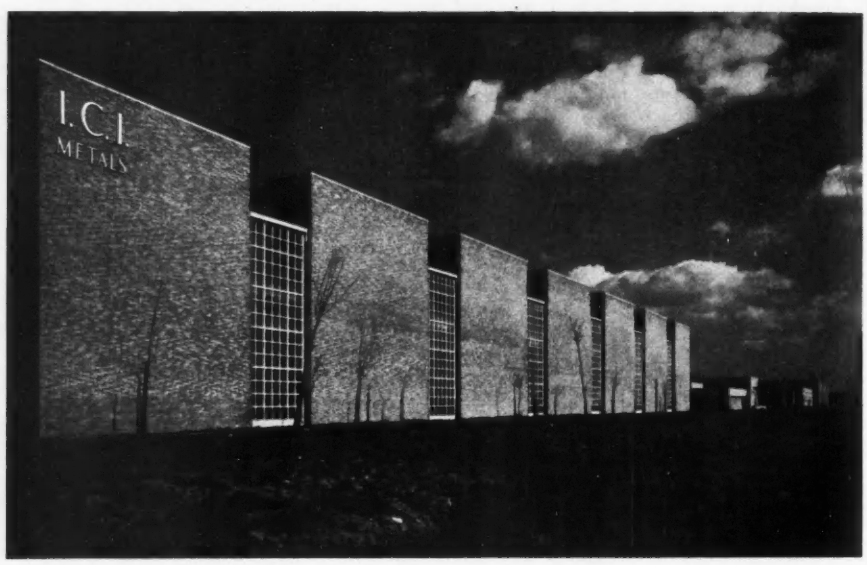


Fig. 1—Each bay of the main structure is 1530ft long by 90ft wide. Part of the exterior of a bay is seen here

A third bay was required to house service sections. To reduce volume, this was designed as a single-storey, flat-roof structure, 28ft wide and 18ft high, running almost the full length of the main building. Smaller production units (casting shop and roller department) and ancillary units such as offices, stores, canteen, boiler-house and fire station were housed in separate buildings. All the buildings have 11in cavity walls and 6in reinforced controlled concrete floor bases with ¼in granite finish, powdered with carborundum and case-hardened. The total superficial area of the buildings is more than 470,000 square feet and the cubic capacity more than 19,000,000 cubic feet.

The demand for cooling water used in production processes—unusually heavy at Kirkby—is catered for by collecting in a central reservoir all storm water from the roof of the 7 acre main mill. This reservoir, with a capacity of 1½ million gallons, is normally sufficient to provide all the cooling water used in production. It is also a source of water for fire-fighting purposes, the pumps for which are operated

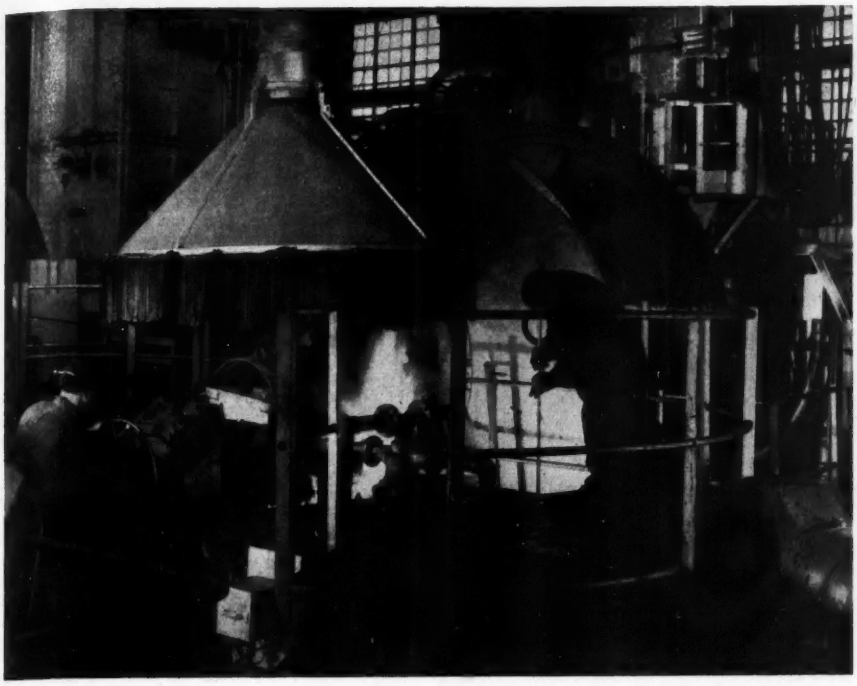


Fig. 2—Casting of copper billets. In the background is the electric arc furnace, which feeds the holding furnace with 5 tons of copper an hour. In the foreground one of two rotary water-cooled moulds is seen

by remote control from the fire station.

The boiler-house is equipped with three "Economic" boilers of the high-velocity, self-contained type, each 10,000,000 B.Th.U. per hour, with room for one further addition. The boilers provide a high pressure hot water supply, principally to a panel heating system. The small amount of process steam required is provided by steam generators from the hot water system.

A feature of the boiler-house is the stack, which was designed in reinforced concrete with a broad band at the top forming a water tower of 25,000 gallons capacity. The object of combining both units was to reduce the number of high structures on the site.

Equipment

The first process, of course, is that of melting the copper and casting it into billets (Fig. 2). The "Efco" electric arc furnace at Kirkby can melt copper ingots, cathode copper and process scrap at over 5 tons per hour. From the furnace the copper runs down launders into a holding furnace in order to stabilise the temperature, to allow for the introduction of other elements, such as phosphorus, when required, and to balance out variations in the melting rate and the demand for billets. The copper is cast into moulds, which for small billets are disposed around the periphery of a rotary water tank. One such tank is disposed on each side of the pourer which can be tilted either way to cast on each side alternately. Ejection of billets from the moulds is automatic.

The smaller billets are pierced in preparation for drawing by the Mannesmann process of feeding the billet at a temperature of about 850 deg. Cent. over a plug, at the same time rotating the billet. After piercing, the "shells" are water-cooled, pickled and worked, transfer between the tanks being automatic. The shells, each weighing 150 lb, next go to rotary swaging machines and squeeze pointers which point them ready for drawing.

On No. 1 drawbench the longest length of tube drawn is 110ft. This Head Wrightson bench is believed to be the longest in the trade. It develops a 300,000 lb pull and its maximum speed of drawing is 360ft per minute. From this bench the tubes go to No. 2 drawbench, illustrated in Fig. 3, which develops a 100,000 lb pull at a maximum speed of 450ft per minute, and draws a length of 160ft, three tubes at a time. The tubes, it will be observed, automatically roll off the bench for intermittent removal by the overhead cranes. No. 3 drawbench is identical with No. 2.

At this stage either of two things can happen to the tubes. For a continuation of the mass-production drawing process to preferred sizes they can be coiled in preparation for delivery to drawblocks; or to meet demands for odd sizes of tubes they can be sawn to suitable lengths and transferred to "B" bay "Oddments Section" for further treatment. There the machines are designed less with high rates of operation in mind than with the ability to make tool changes quickly.

For a continuation of the mass-production process the tubes from Nos. 2 and 3 drawbenches, now 160ft long, are coiled. In this condition they can no longer be drawn further on machines in which the plug is mounted on a long tie-rod. Instead a floating plug is used. It is so shaped that the frictional forces which act on it during the drawing process, as the tube is squeezed over it on being pulled through the die and which tend to draw it into the die, are exactly balanced by the pressure developed in the tube walls. This pressure, of course, tends to force the plug away from the die. At a drawblock the first operation has to be a hand one. A hammer is applied to the tube a few inches from its end to make a dent in it; the plug is next inserted, being retained in position by the dent, and the end of the tube is then inserted in a machine to be swaged down for entry into the die. Fig. 4 shows the drawing process in progress. The coil in the foreground is the original tube, that in the background the tube drawn to a smaller diameter and recoiled. The Marshall Richards drawblocks continue to draw the full weight of the original tube at speeds up to 1800ft per minute, with the result that a single shell can be drawn out into a single tube up to 2000ft long.

The coils, of course, can be much more easily handled and stored than the 160ft straight

Fig. 3—No. 2 drawbench is capable of drawing tubes, three at a time, up to lengths of 160ft at speeds up to 450ft per minute

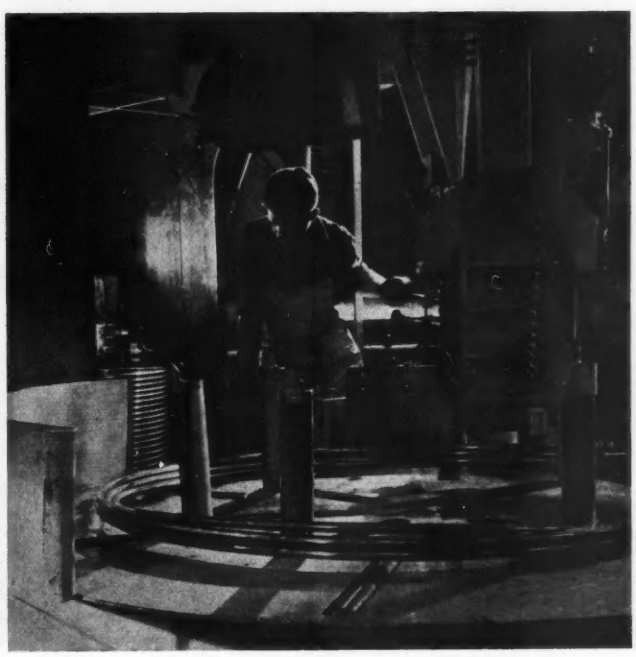


Fig. 4—On this vertical drawblock coiled tube can be drawn at speeds up to 1800ft per minute

Fig. 5—As compared with the handling of straight tube, coiled tube can be simply handled by rigid mast crane

tubes produced by the drawbenches. The illustration, Fig. 5, shows coiled tube being transported by rigid mast crane. Experiments are now being made to see whether it would be practicable to make the coiling of the finished tube spiral, an arrangement which would facilitate storage and packing for transport through the saving of space which would result.

For the manufacture of larger tubes the extrusion process is used for the production of shells. There are two Fielding and Platt presses. One is a back extrusion press of 1500 tons capacity. It deals with billets for large diameter tubes and solid rollers. The other is a forward extrusion press of 2500 tons capacity which handles 450 lb billets and extrudes shells 30ft long, about three times the length and weight of the shell produced on the piercer. This machine is shown in Fig. 6. Its products can go either to the mass-production line or be used for the manufacture of larger diameter tubes. In the large tube area shells are drawn down to size on Wellman Smith Owen benches designed for producing tubes up to 14in diameter. They are highly mechanised, with particular emphasis on quick tool changing.

Copper Rollers

Among the tube products for which I.C.I. has become well known are copper rollers for textile printing and electrodeposited rollers for textile and paper printing. This work was originally carried out at the Broughton Copper Works, and on its transfer to Kirkby the solid roller department was modernised and the electrodepositing department completely re-equipped. Solid rollers are produced from the cast billet on the back extrusion press, like shells for large tubes, but during the punching operation a key is formed in the bore of the shell. The shell is then cold rolled, fitted to an exact position on a tapered mandrel by mechanical hammering, turned to size and polished. The finish of the polished roller is of great importance, and at Kirkby special equipment has been designed to ensure a consistently high quality of finish, which is checked by a Talysurf machine.

Copper deposited on either copper or cast iron base is also used for textile printing, and during recent years there has been a big increase in the demand for electrodeposited rollers for photogravure printing. These also are made at Kirkby.

"Integron" Finned Tubing

A recent development in tube fabrication has been the "Integron" finned heat exchange tube. As opposed to types on which the fin is wound or brazed on to the tube, the "Integron" fin is integral with the tube. It is formed by "thread rolling" a thick gauge tube so that much of the metal in the wall is displaced into the fins. "Integron" is produced with either a high or a low fin, depending on the use to which it is to be put. Such a tube has obvious heat transfer advantages and is particularly suitable when it is necessary for the finned tube to be bent or where excessive vibration is encountered, because it is impossible for the fins to become loosened from the tube. Finned tubes are produced in copper, aluminium and a number of copper alloys. It is also possible to produce bi-metal finned tubes, in which the fins and the outer wall are in copper or aluminium and the inside of the tube is in steel, titanium or any of the copper alloys.

The Kirkby Works is believed to be the largest copper tube factory in the British Commonwealth and its main mill—more than 7 acres under one roof—is the largest in the British non-ferrous metals industry and is believed to house the most powerful tube-drawing machinery in the world.

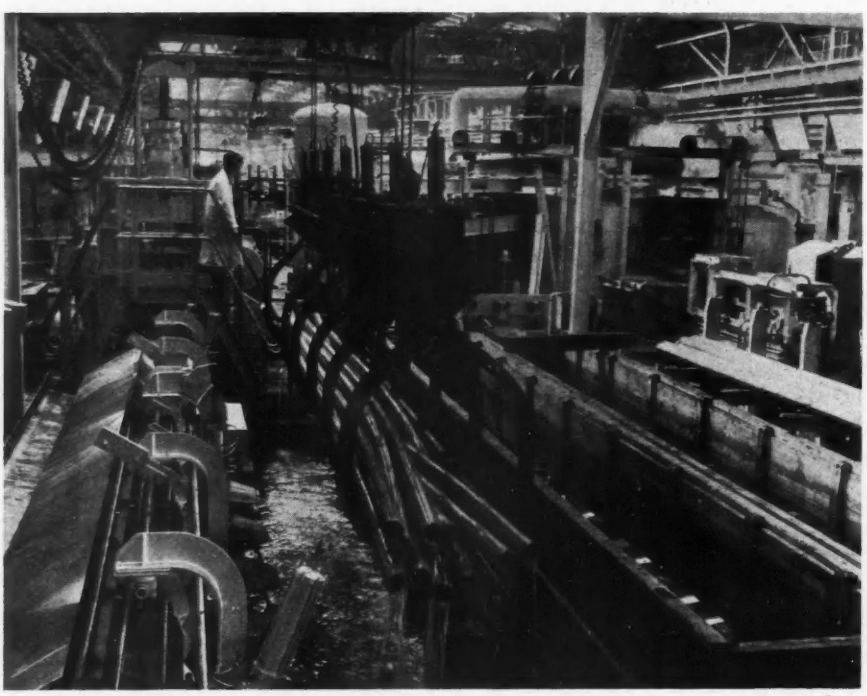


Fig. 6—Discharge gear for 2500-ton forward extrusion press, producing shells 30ft long from 450-lb billets. There are pickling and washing tanks to be seen in the foreground

Chemical Nickel Plating

A process of plating by catalytic reduction is to be established in this country by Albright and Wilson, Ltd., 49, Park Lane, W.1, and is termed Kanigen chemical nickel plating. The plate is deposited by immersing the object, cleaned and properly prepared, in a bath containing a nickel salt and a hypophosphite at about 98 deg. Cent. Catalytic centres, which will be present on the surface of the object, initiate the deposition of a film consisting of nickel and about 8·5 per cent of phosphorus as a nickel phosphide. The growth will be even in a uniform solution, without regard to the contour of the part. The materials that can be plated include most ferrous and non-ferrous metals, excepting cadmium, lead, tin and, therefore, soldered parts, and also plastics, ceramics and glass.

In the case of non-metals a matt finish is needed on the part and reproduced on the plate. Where a polished finish is required, a very thin coat of Kanigen can be applied, the object copper-plated and polished, and then Kanigen or electro-plate finish applied.

On metals the 100 per cent throwing power of the solution results in the ability to plate complicated and recessed objects that could not be electro-plated. The corrosion resistance appears to be superior to that of nickel plating and it is suggested that Kanigen plated steel or aluminium may be preferable to stainless steel in some applications. The plate is both hard and adherent: hardnesses of 500 D.P.N. can be doubled by heat treatment at around 400 deg. Cent., while the adhesion to steel is 30,000 lb to 60,000 lb per square inch and no chipping or flaking takes place in a tensile test to destruction. The elongation of the plate is 3 to 6 per cent, and no stress failure occurs as long as the basis metal does not pass its elastic limit. Low carbon steel samples, plated and uncoated, have nearly identical fatigue life. Since the plate is so hard, polishing should precede plating. The thickness of the coat being easily controllable within 10 per cent of its average, with no tendency to build up on external angles, reclamation of worn or undersized parts can frequently be performed without subsequent grinding.

Opening of Weir Wood Reservoir in Sussex

ON Monday last, September 19th, the Weir Wood reservoir near Forest Row, in Sussex, was inaugurated by the Duke of Norfolk. Impounding schemes for water supply in that county are still somewhat unusual, for most of the water used is drawn from underground sources. But a survey carried out in 1944 by the Ministry of Health showed that underground sources were being pumped in excess of capacity and yields were falling away. The alternative was to develop a surface source of supply, and the present scheme was chosen from two alternative proposals, both based on surface supply. Like other impounding reservoirs in this part of the country, such as the Darwell reservoir which forms part of Hastings' water supply system, only the winter rainfall yields an appreciable run-off which can be stored in the reservoir.

The main purpose of the new reservoir is to give a water supply to the new town of Crawley, but a number of neighbouring rural districts also benefit from the scheme. It has been built under the jurisdiction of a new water authority—the Weir Wood Water Board—which was formed in 1949 specifically for the purpose of facilitating comprehensive development of the water resources of the area, a problem which the designation of Crawley New Town brought to a head. An account of these administrative and technical problems underlying the Weir Wood scheme was given in our issue of September 21, 1951, in the article "Engineering Aspects of the New Town of Crawley," which included sectional drawings of the Weir Wood dam. The principal statistical data relating to the reservoir are given in the accompanying table. It is estimated that about two-thirds of the yield will go to Crawley New Town, and a third to the various neighbouring rural districts. A second scheme is envisaged later on, when the growth of the new town demands.

Statistics of the Weir Wood Water Supply Scheme

Reservoir :	
Drainage area	6500 acres
Gross yield	4 m.g.d.
Compensation water	1 m.g.d.
Net yield	3 m.g.d.
Storage capacity	1270 m.g.
Top water area	300 acres
Area of supply in East Sussex	112 square miles
Dam :	
Total length	1680ft
Maximum height	41ft
Width at crest	15ft
Width at base	300ft

Weir Wood dam is an earthen embankment, with a puddle-clay core-wall and a concrete cut-off. It has a concrete facing on the upstream side, surmounted by a wave wall, as the first illustration shows. The dam is built across a shallow valley in the upper reaches of the River Medway, near Forest Row, and thus impounds the headwaters of that river.

The geological formations of the site are the Wadhurst clay and Ashdown sand and consist generally of alternating beds of shales, mudstones, soft and harder sandstones, with fine bands of clay. On the whole, the strata were found during construction to be regular, but bedding joints and vertical fissures were frequently open or filled with a fine silt. The concrete cut-off trench is 1852ft long and 6ft wide, except for the top 8ft where the trench was widened to provide a seating for the puddle clay; it has a maximum depth of 80ft. Horizontal sheeting and vertical soldiers were used in the timbering except in very poor ground where vertical runners were necessary. Three inch horizontal sheeting in 15 ft lengths was supported by 12 in by 6 in soldiers, 4 ft 6in long, with struts of the same section at midpoint. The trench was sunk below the level of the base, and the clay puddle core-wall carried to the top of the embankment.

Excavation of the top 12 ft to 16 ft of the trench was by backacter. On the steeper sections of the valley sides terracing by bulldozer had to be carried out ahead of the digger. In wet weather it was difficult to prevent the trench falling in across the river flat, and the advantages of mechanical digging were, therefore, partly offset. The remainder of the trench was excavated by hand digging, the muck being hoisted in ¾ cubic yard skips by steam cranes travelling on standard gauge track. An early attempt to use crawler-mounted cranes proved unsuccessful due to the difficulty of travelling these machines on the clayey ground, particularly up and down the valley sides. Some 20,000 cubic yards of concrete were pumped into the trench over distances of 300ft to 1000ft.

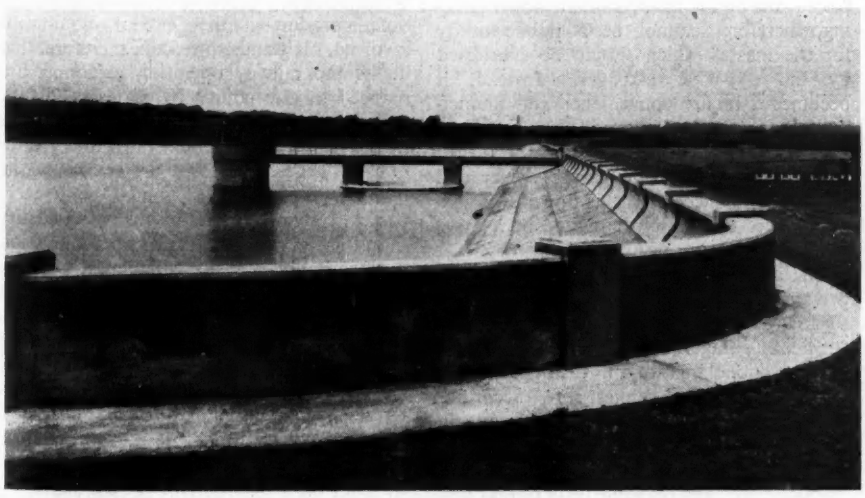
The excavated material was passed as suitable for the embankment fill and was generally spread by bulldozers from the spoil heaps formed alongside the crane tracks by the tipping of the skips. The outer embankment material consisted mainly of soft sandstone excavated by face shovels in borrow pits within the reservoir area and transported to the dam by lorries and loco-drawn tipping skips.

The river was diverted through a 10ft diameter concrete tunnel about 650ft long, round the southern end of the embankment. A bellmouth concrete overflow chamber, illustrated herewith, discharges into this diversion tunnel; scour and compensation water pipes are incorporated in this tunnel construction. On the line of the diversion tunnel a concrete valve shaft has been constructed with two draw-off valves at different levels. From this point water is taken to a treatment plant, situated immediately downstream from the reservoir. Coagulation with sulphate of alumina is the first stage of treatment, followed by settlement in sedimentation tanks, rapid gravity filtration and sterilisation with chlorine. The treated water is then pumped to service reservoirs.

Here we show a closer view of the valve tower and bellmouth overflow chamber which discharges into the diversion tunnel

One aspect of the constructional work which should be mentioned was the cementation of the strata below the bottom of the cut-off trench of the embankment. This was done through 2in diameter pipes left in the concrete core at intervals of about 10ft. Boreholes were drilled through the pipes from the top of the concrete "tongue," and neat cement grout injected under pressure, the holes being subsequently plugged. The sequence of operation at each hole was to drill below the pipe, test with water under pressure, inject grout and afterwards maintain pressure for twenty-four hours to allow it to harden. After flushing the operation was then repeated for further stages of 10ft. At the north end of the embankment cementation was continued along a line upstream of, and at 70 deg. to, the centre line of the embankment forming a screen connecting with watertight strata. The total number of holes drilled was 215 and 1127 tons of cement were injected.

Work on the reservoir was started in 1950 and completed in 1953. Impounding commenced on May 1, 1954, and water overflowed for the first time on December 27, 1954. The consulting engineers were Herbert Lapworth Partners and the contract was carried out by Richard Costain, Ltd.



The Weir Wood reservoir at Forest Row in Sussex has a storage capacity of 1270 m.g. and will supply up to 3 m.g.d., principally to the new town of Crawley. It impounds the headwaters of the River Medway

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BITUMEN SEALER.—We are informed by Allweather Paints, Ltd., 36, Great Queen Street, London, W.C.2, that it has just introduced a new product called "Pitan" bitumen sealer. This material has been designed for use where it is required to brighten works, but for a variety of reasons it is not possible to effect complete removal of bitumen present on treated surfaces. The new sealer acts as a barrier and prevents unsightly "bitumen bleed." It is supplied only in white and it can be overpainted with any decorative and/or protective finish.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE CITY TRAFFIC PROBLEM

SIR,—I am sure all your readers will have read with great interest, as I did, the description by Dr. Glanville and Mr. Moore of how the city traffic problem is being tackled in the large American cities. They report that "the old-fashioned practice of improving road systems by building fresh roads at the same level as existing roads, and thus multiplying the number of intersections, was not seen in America. The new city highways are freeways and pass over or under existing roads." Let us hope any new major highways that we may build in urban areas will take the form of such freeways or expressways. But let us not suppose that such facilities by themselves would solve our urban traffic problems. The Americans are finding otherwise. The authors referred to the view of the town planners, whose solution "is to persuade people to travel by private car to a parking station and then travel by rapid transit to the city." This view is supported also by many traffic engineers. Two past-presidents of the Institute of Traffic Engineers were members of a television panel which recently discussed the question "What's Happening Downtown?" and later issued a summary (published in *Traffic Engineering*), which contained the following passage :—"Our experience has indicated that we can never provide all the space needed for growing automobile traffic downtown. The harder we try, the more we spend—on widening streets originally built for horse-and-buggy traffic, and on demolishing buildings to make way for parking, and on constructing expressways and freeways to make it easier for motorists to drive downtown—the worse our traffic congestion becomes. These steps serve to attract still more automobiles into the central business district. It should be made clear that this is not to say that all effort to provide additional facilities for motor vehicles should be stopped. The point is that the urban transportation picture is out of balance; that our experience shows clearly that what we have been doing is like running on a treadmill. It's becoming increasingly clear that even in this great and rich country there are financial and physical limitations to what we can do to accommodate individualised transportation. We need a better balance between the use of private and public transportation—especially in congested downtown districts. .... We can make better use of the facilities and the street space we have. Greater use of public transit is being recommended with increasing frequency by experts—traffic engineers, city officials, city planners—as the least expensive, immediately available facility for reducing the number of vehicles downtown."

Strangely enough, it is also being recommended not only by the Chamber of Commerce of the United States, but also by the owners of private parking garages. One of these—Mr. Campbell, of Oakland, California—recently addressed the National Parking Association as follows :—"Mass transportation on the horizontal, and mass transportation on the vertical, by elevators and escalators, create a space demand for parking in the downtown area that is physically impossible to fulfil, and government intervention appears futile. (It should be mentioned in passing that the elevators and escalators in New York City transport more persons than all other forms of transportation, and are in themselves a great mass transportation vehicle.) The transit lines in Oakland, California, transport on the average each week day 200,000 persons into the heart of the central business district, and return them to the point of origin in neighbourhood and suburban districts. An average of less than two persons ride per car. It would, therefore, require 100,000 private automobiles, in addition to those already coming into town by private car, to transport the bus equivalent. The transit system handles this volume with less than 1000 buses, or a ratio of one bus that does not require off-street parking to 100 automobiles that would require parking. The buses are warehoused in yard areas in the low-priced industrial sections of the city. The proposal that the city should provide terminal facilities for the private automobile is comparable to suggesting that we should place the railroad yards in the heart of the city where the passenger terminals are located. The proposal is fantastic. The downtown advocates of municipal parking are the advocates of the greatest traffic delusion of the age, and they should be giving more of their attention to the fast flow of mass transportation vehicles. Parking availability responds to price. If parking rates were doubled, there would be available space. If parking rates were reduced by one-half, still fewer spaces would be available. Obviously, as the parking location becomes closer to the generators of the demand in the downtown area, the rates must be higher and the masses are priced out of the facility. Downtown parking, therefore, cannot be a public utility for the masses which should be subsidised by the city-wide taxpayer. Instead, it becomes a luxury convenience and municipally owned garages would be, in effect, 'public housing projects for underprivileged Cadillacs.' The private garage owner and operator can succeed in this downtown area only where the supply is limited in relation to the high income or luxury demand."

The above is a pungent statement of the private garage owner's case against what he regards as unfair competition from publicly subsidised garages, and also from free parking on the public highway. ("Curb parking is boondoggling of the rankest sort," according to another speaker.) It is based on the premises that (*a*) parking space is not a public utility, nor "more parking" a city responsibility, and (*b*) some form of rationing in the use of downtown street space is required, and "rationing by price"—through high parking fees—is preferable to rationing by congestion or rationing by administrative edict.

So far, private garage operators in this country have not been very vocal in opposition to government-subsidised parking. However, one of them, Mr. L. F. Dyer, told the National Parking Association that, if the same percentage of Londoners brought their cars downtown as did Chicagoans and New Yorkers, the British capital would suffer complete paralysis. If radial expressways were built in London, they would—other things being equal—greatly increase the demand for parking space in Central London, especially for all-day parking. But the demand, as Mr. Campbell points out, is affected by the price. In the central areas of large American cities, all-day parking costs more than a dollar a day (say, 8s.). If we do build expressways, we shall have to face up to the need to limit the demand which would otherwise arise for more street space and parking space. Perhaps the best method would be to adopt "rationing by price"—by simply letting the cost of parking in the central area reflect the real cost of providing parking space in an area of high land values, created by mass transportation. And let us not neglect to develop our public transport facilities, along with facilities for individualised transport.

NIGEL SEYMER

London, S.W.11, September 15th.

DAMAGING EFFECT OF INFLATION

SIR,—In your admirable leader, "Agreement on Economics," you rightly stress the damaging effect of inflation, but you go on to say that "nowadays, industrialists and union leaders so well understand the nation's economics that there is in reality little room for disagreement amongst them."

In the case of the badly needed modernisation of the railways, involving an expenditure of £1200 million during the next fifteen to twenty years, approximately 120,000 people will be employed during the whole of this time, producing the capital equipment involved. It stands to reason, therefore, that unless the railway operating personnel are reduced in due course by at least 120,000, there is bound to be inflation, including higher fares and goods rates or greater railway losses. On the other hand, the N.U.R., at its recent annual conference, passed a strong resolution that its executive should insist with the Transport Commission that there should be no redundancy.

If the leaders of the employers and unions have the answer to this fundamental problem, which also applies to the other non-expanding industries, it would surely be helpful to the nation if they would proclaim it widely. Until they do so, inflation and restrictive practices will continue, despite all exhortations at all levels.

ANTONY VICKERS

Isleworth, Middlesex,
September 19th.

Literature

Magnetic Amplifiers. By H. F. STORM. London : Chapman and Hall, Ltd., 37, Essex Street, Strand, W.C.2. Price 105s.

THE author has been in the forefront of magnetic amplifier analysis and development in the U.S.A. and is particularly noted for his work on amplifiers with inductive loads. Although magnetic amplifiers are very simple in external physical form, their analysis, design and assessment as circuit elements is difficult and complicated. The book attempts to overcome these difficulties by explaining the fundamentals underlying their operation as simply as possible and by giving the engineer and senior student a general theoretical background of the subject for design and application.

A good general treatment for the conventional single-phase magnetic amplifier is given. The analysis starts with the simple transductor and progresses to higher order types with feedback, culminating in the self-saturated amplifier (or mag. amp.). Inductive loading is very fully covered and many aspects of its external manifestation, such as amplifier instability, are lucidly explained. Although push-pulling of amplifiers and the quick response single core circuits are described the analysis has not been applied to these circuits. The analysis of the simple transductor circuit follows along conventional lines. The hysteresis loop has been approximated to a rectangular shape the width of which, although neglected in the initial analysis, is later tied up with an ampere turn correction factor. The key to the analysis on magnetic amplifiers with feedback lies in the assumption that the magnetomotive force on the unsaturated reactor is zero during the conducting period of the other reactor provided the input circuit resistance is small. A core correction factor is introduced to take care of cases where this assumption is not valid. The analysis gives a new outlook to magnetic amplifier theory in which the width and not the much accepted slope of the dynamic hysteresis loop is the controlling factor in determining gain. The author indicates that in particular cases very good agreement between theory and practice can be realised. The representation of the saturable reactor as an amplifier, the open loop gain of which is determined by the core characteristics, with intrinsic current feedback is particularly illuminating. This interpretation is associated with a very instructive explanation of the transductor operating under transient conditions. The block diagram representation of the magnetic amplifier transfer characteristics, suitable for direct integration into control systems, will be valuable to the servo engineer. Other design topics which are well emphasised are the effects of rectifier characteristics on performance and the difference between magnetic and electric feedbacks. The mathematical techniques are simple and well within graduate level. The reduction of the magnetic amplifier circuit to its simple linear equivalents between the non-linear change points gives excellent clarity to its mathematical representation. The author's graphical technique of building up circuit waveforms from basic linear components is also particularly noteworthy. It is difficult to generalise in this field without introducing extensive symbolisms and the reader may find continual reference to nomenclature and preceding equations irritating if not troublesome.

Certain aspects of the theory are open to criticism. This can be mainly directed at the theoretical assumptions which are not propounded with the same lucidity as the rest of the work. The inquiring reader will find the following points treated indifferently by the author. The effect of input control resistance has a marked effect on the core resetting and the transient study of mag. amps. The hysteresis assumption gives infinite gain predictions under certain conditions of magnetomotive force bias on the cores. Disagreement is found throughout the book on an important aspect of the theory. Sections 14.6 and 18.2 state that magnetic amplifiers are primarily independent of the supply voltage whereas the theory, equation 16.3, deduces its dependence on this quantity. The chapters devoted to magnetic amplifier application are not on the same level as the rest of the book and are very poorly integrated with the theoretical treatment. The designer will have difficulty in utilising the theoretical results and find very little definite information about the expected design accuracy. The treatment would have appeared much more convincing if the listed performance figures of some typical amplifiers had been broken down into the basic quantities of the theory. Design figures for core factors and drift have also been omitted.

Although the focal point of the book is Dr. Storm's theory of magnetic amplifiers, valuable contributions on related subjects are given by his associates. The introductory chapters on theory of magnetism, magnetic materials and magnetic measurements give an excellent short survey of the present state of this art. The chapters devoted to magnetic amplifier manufacture and modern practice give a good background and contain a wealth of information on these important topics. Numerous applications of magnetic amplifiers are described in the concluding chapters. These, along with their extensive bibliographies provide a very valuable reference for the engineer who is considering their application to a specific problem.

The book can be thoroughly recommended to the student and research worker provided they read it critically. They will find Dr. Storm's theory extremely stimulating and a useful basis for future research. However, before the treatment can be used to answer the practising engineer's problems, certain theoretical shortcomings have to be clarified and the theory enlarged to take into account push pulling of stages and single core reactors. The lack of information on certain aspects of the subject is compensated to some extent by the very complete bibliographies appended to each chapter.

Plant and Process Ventilation. By W. C. L. HEMEON. London : Bailey Bros. and Swinfen, Ltd., 46, St. Giles High Street, W.C.2. Price 26s. 6d.

BRITISH readers of books from the other side of the Atlantic are not infrequently exercised by the standard vocabulary used by their American authors. The reader approaches with some apprehension, therefore, the American book which, in its introduction, claims leave to take some language liberties and coin some special words and phrases such as "pulvation," "inertials," and others. Fears, however, are soon dispelled as one embarks upon the early chapters dealing with fundamentals of the subject. The word "pulvation," for example, has been ingeniously derived to be applicable to dust in the sense that the word "evaporation" is applicable to liquids. Thus, "pulvation" is defined as "the non-molecular mechanical or physical process whereby dust or mist becomes suspended in air from a previous state of rest."

After investigating, in the first four chapters the objectives of ventilation and the theoretical basis upon which such objectives are converted into terms of successful plant design, Mr. Hemeon devotes the remainder of his book to the presentation of design data, always with a bias towards the application of ventilation design required for various industrial uses. Much of the information presented is, of course, available elsewhere, if the trouble is taken to discover it, but the particular attraction of this book is the assembly of a vast amount of practical data clearly derived from a very wide experience of field work. Chapters of special interest and practical value are those dealing with problems of exhaust from hot processes, characteristics of free air jets, design of various types of hoods, and natural draught. Frequently the design methods postulated are illustrated by working through practical problems. In addition, space is devoted to the more conventional subjects of duct design and air cleaning.

This book is, at once, a detailed textbook for the student and a reference manual for the practising engineer. The collection of established data and new ideas amassed for a wide variety of applications would make the book a valuable possession for the engineer who may continuously or intermittently be concerned with plant and process ventilation.

Navires de Guerre d'Aujourd'hui. By the Groupement d'Exportation de Navires et d'Engins de Mer en Acier, 1, Boulevard Haussmann, Paris (9e).—This book, which is produced in loose leaf form, opens with a foreword explaining the present trends in construction for the French Navy and briefly reviewing the development and introduction of the various light classes of warship. Some of the great names in French shipbuilding and engineering are given and the Ecole Nationale Supérieure du Genie Maritime noted as being the principal centre for the technical training of naval architects. More detailed accounts of light naval craft are given in separate sections of the book and relate to destroyers, anti-submarine escorts, minesweepers, patrol craft and boom defence vessels, and submarines. Each section describes the war and post-war developments and discusses the main points of design and performance regarding the hull, armament and the propulsion machinery of the class of ship to which the particular section refers. In the second part of the book there are a large number of drawings, consisting of elevation and plan view, of various warship projects prepared by French shipbuilders. Each drawing is accompanied by tabular statements which set out the main particulars of the ship, including the displacements, principal dimensions, machinery particulars, details of the armament and the ship's complement. The drawings refer to various classes of destroyers, escort, patrol and boom defence vessels, minesweepers and submarines. The text is printed in four languages, French, Spanish, Portuguese and English.

Books Received

Land, Water and Food. By Herbert Addison. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 18s.

Industrial Power Systems Handbook. Edited by Donald Beeman. London : McGraw-Hill Publishing Co., Ltd., McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 94s.

Constructional Steelwork. By Oscar Faber. London : E. and F. N. Spon, Ltd., 15, Bedford Street, Strand, W.C.2. Price 50s.

Turboblowers. By A. J. Stepanoff. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 64s.

Plastics Tooling. By Malcolm W. Riley. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 20s.

Basic Lubrication Practice. By Allen F. Brewer. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 54s.

General Mechanical Drawing. By William Jervis. London : Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 21s.

German Machine Tool Exhibition

No. I

THE German Machine Tool Exhibition was held at Hanover, from September 11th to September 20th. Although it was intended to be mainly a national exhibition, sixty-one of the 592 participants were firms from abroad, the largest number of foreign exhibitors coming from Switzerland and Austria. It is not intended here to give an exhaustive description, but rather to present a general picture and subsequently to concentrate in detail upon some of those machines which showed particular advances in respect of design, capacity, or novelty of application.

The exhibition showed the important position the machine tool industry now occupies in the German national economy. Although this branch of industry is only one of some 1000 others represented on the Federation of German Industry, it employs rather more than 1 per cent of the country's total industrial labour force of 6·2 million persons, or 10 per cent of the force engaged in the mechanical engineering industries. Its annual turnover has for the past few years been in the region of D.M. 1000 million, and about one half of the industry's products are exported. This compares with about one third to one-fourth before the war—although the volume of exports was higher then. In terms of the whole of the machinery exported by Germany at the present time machine tools represent about 14 per cent. As was the case before the war 70 to 75 per cent of the machine tools exported go to countries in Europe.

Statistics show that the present volume of production of the machine tool industry in Germany was substantially reached in 1952, and it has remained fairly constant ever since. Orders received during 1954 exceeded production by some 25 per cent and it is estimated that, on average, order books are now full for ten months to come. While delivery dates vary widely according to the types of machine tools, about 50 per cent of the deliveries quoted are stated to be between 6 and 15 months.

Exhibits at this year's show, which is the first national event organised by the Verein Deutscher Werkzeugmaschinenfabriken(V.D.W.), occupied ten halls at the Hanover exhibition grounds, covering an area of about 60,000 square metres. They comprised all kinds of metal-working and precision tools, as well as accessories, measuring instruments and testing gear. Owing to an agreed weight limit of 40 tons, in the case of some of the very largest machine tools only the most important components, such as workheads, were on view.

The general picture of the industry was completed by the addition of a section "Iron and Steel," showing a selection of castings, rolled sections and other items used in the construction of machinery, and by a section devoted to the economics of tooling and tool maintenance, which had been arranged by the Arbeitsgemeinschaft Deutscher Betriebsingenieure (A.D.B.), in co-operation with outside reports and firms, the German Productivity Council, and the Landesgewerbeamt Stuttgart. Part of this section dealt with safety measures and included a particularly effective series of posters.

In addition to the very large number of standard types of machines shown, there were also exhibited many machines of special design and construction for high production rates in the automobile and other industries. In many cases, the makers made full use of standard heads arranged round central indexing fixtures or on transfer lines to complete the required sequence of operations. It was interesting to note that on many machines the use of normal operating handwheels had been replaced by grouped push-button controls, and some interesting applications of programme control were to be seen.

Several horizontal and vertical milling machines on the stand of Gebr. Heller, G.m.b.H., Nuertingen, Wuertt, 205, incorporated push-button operation and programme control. One of these machines, a vertical miller, is illustrated in Fig. 1, and horizontal machines of very similar design were also shown in operation. This machine has a table with a working surface of 78in by 18in, with a longitudinal stroke of 55in, the transverse adjustment being 16in and the vertical movement 18in. Its spindle is designed to take cutters up to 20in diameter and two speed ranges covering from 28 to 900 r.p.m.

Individual spindle speeds are selected either by a lever controlling sliding gears or, as on the machine exhibited, by electromagnetic disc clutches. Electromagnetic clutches on the main driving shaft are used at the same time for disconnecting the drive while the motor is running, while the clutches on a third shaft may serve for quick braking of the cutter spindle. An electric preselector on the control panel of the machine facilitates setting the required speed. By operation of a sliding clutch the 9-speed drive may be transmitted through multiple vee-belts for the high speed range, or through a reduction gear for the low speed range. The two lower speeds of the belt transmission are the same as the two top speeds of the reduction gear and sixteen different spindle speeds may be selected. All feed movements of the table are hydro-mechanically operated and a separate hydraulic motor used for each movement drives its feed screw through suitable reduction gearing. The stepless transverse and longitudinal table feed movements range from $\frac{1}{2}$in to 50in per minute and the vertical feed movement from $\frac{1}{16}$in to 12$\frac{1}{2}$in per minute ; and each movement incorporates rapid traverse.

As can be seen from the illustration, the push buttons and rotary switches used for controlling the machine are conveniently grouped on a panel at the front of the knee. Immediately below the inclined push-button control panel are the rotary switches for varying the feed and speed rates of the various movements. Tell-tale lights built into the push buttons are illuminated as they are depressed and the movement called for only commences when the corresponding push button is released, and it may be

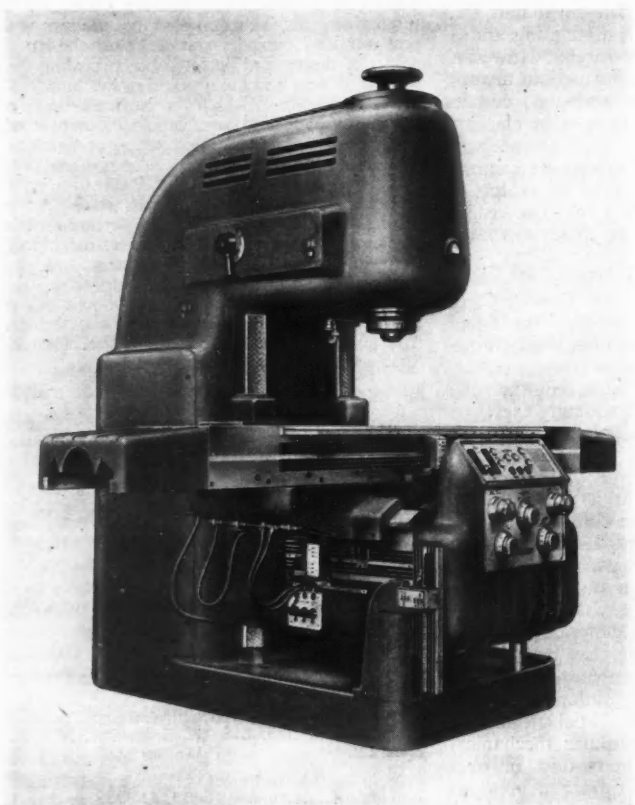


Fig. 1—Heller milling machine with push-button control and automatic work cycle

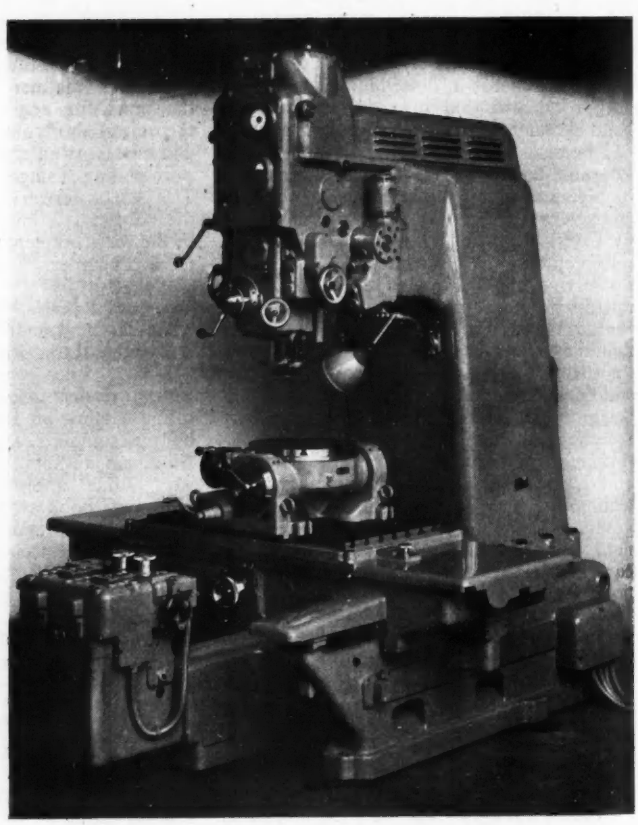


Fig. 2—Jig borer with optical projection system for setting the tables, preselector and automatic table locking

stopped at once by pressing any of the buttons. Slides fitted with cams on the table, saddle and knee actuate switches for the automatic control of the moving machine numbers. These cams are clearly marked for rapid traverse, feed, reduced feed and stop, and may be locked without interference in the separate tee-slots for all directions of movement. The limit stops can be set by micrometer and the length of travel with a tolerance of ±0·0004in is reached by changing to slow feed shortly before the limit stop is reached.

For automatic-cycle work a number of types of programme control can be supplied for the machine. For machining large and medium work batches there can be used a controller with rotary switches with pointers which are set to the desired sequence. This controller enables the machine to be set for a programme with up to ten changes of direction. Another controller permits frequent changes in the programme, and is suitable for the production with it of small batches. The cycle is registered by the operator, who presses the push buttons for the various movements and speed changes in correct order. After completion of a batch, the programme may be cancelled, when the selector switches return to zero position and are available for the registration of a new programme.

In another controller developed for mass production of one or several components, the actual programmes are produced by connecting the circuits through multi-pin plugs, which are wired to obtain the desired sequence. The cycles are changed by simple interchanging of these plugs. If some programme is discontinued completely, the corresponding plug may be modified to give another cycle. With this method very elaborate programmes including simultaneous changes of speed, feed and direction may be obtained.

It should be mentioned that machines made by Gebr. Heller, G.m.b.H., are handled in this country by Wickman, Ltd., Coventry.

In Fig. 2, there can be seen the "L.B.15" jig borer made by Herbert Lindner, G.m.b.H., of Berlin-Wittenau, which is distributed in this country by the Stedall Machine Tool Company, 145, St. John Street, London, E.C.1. This machine is fitted with an optical measuring system and preselector mechanism. Its table has a working surface 44in by 24in and the distance between the surface and the boring spindle is adjustable between 10in and 29½in. The spindle head has a vertical adjustment of 10in on the column and in it the spindle has a travel of 10in. A stepless range of spindle speeds from 25 to 1900 r.p.m. is available and the spindle feed rate ranges from 0·0012in to 0·0064in per revolution.

The optical measuring system consists of precision measuring scales, incorporated in the co-ordinate tables. It consists of mirror-finished cylinders, on which a helical line with high pitch accuracy, serves as a graduation. With this equipment it is stated that the division of the lead can be done to within 0·00005in by a graduated drum with its vernier. The sighted point of the measuring scale is projected by the optical system, and magnified on to screens on the control console of the machine where the image of the helical scale setting is centred between reference lines. To augment the accuracy of positioning, the projection system is also equipped with an optical-photoelectric centring device, indicating the zero position when the image of the scribed line is exactly centred between the reference lines.

To reduce the time required between boring operations a preselection system is fitted for the rapid setting of the longitudinal and transverse co-ordinate tables. With this preselector it is possible to determine the table position for the next hole whilst a boring operation is in progress. The preselector has illuminated setting dials, on which the amount of table traverse required is set to within 0·00005in, using graduated drums and verniers. When the preselector starting knob is depressed, the tables move automatically, in rapid traverse, to the vicinity of the preselected position and only a small correction is then needed to set the table into the final position.

On practically every stand there was at least one machine incorporating in its design, or fitted with, copying apparatus, and amongst the larger machines of this kind there was shown in operation the automatic copying machine in Fig. 3. This machine is made by Heyligenstaedt and Co., Werkzeugmaschinenfabrik, G.m.b.H., Giessen, represented in this country by Burton Griffiths and Co., Ltd., Kitts Green, Birmingham.

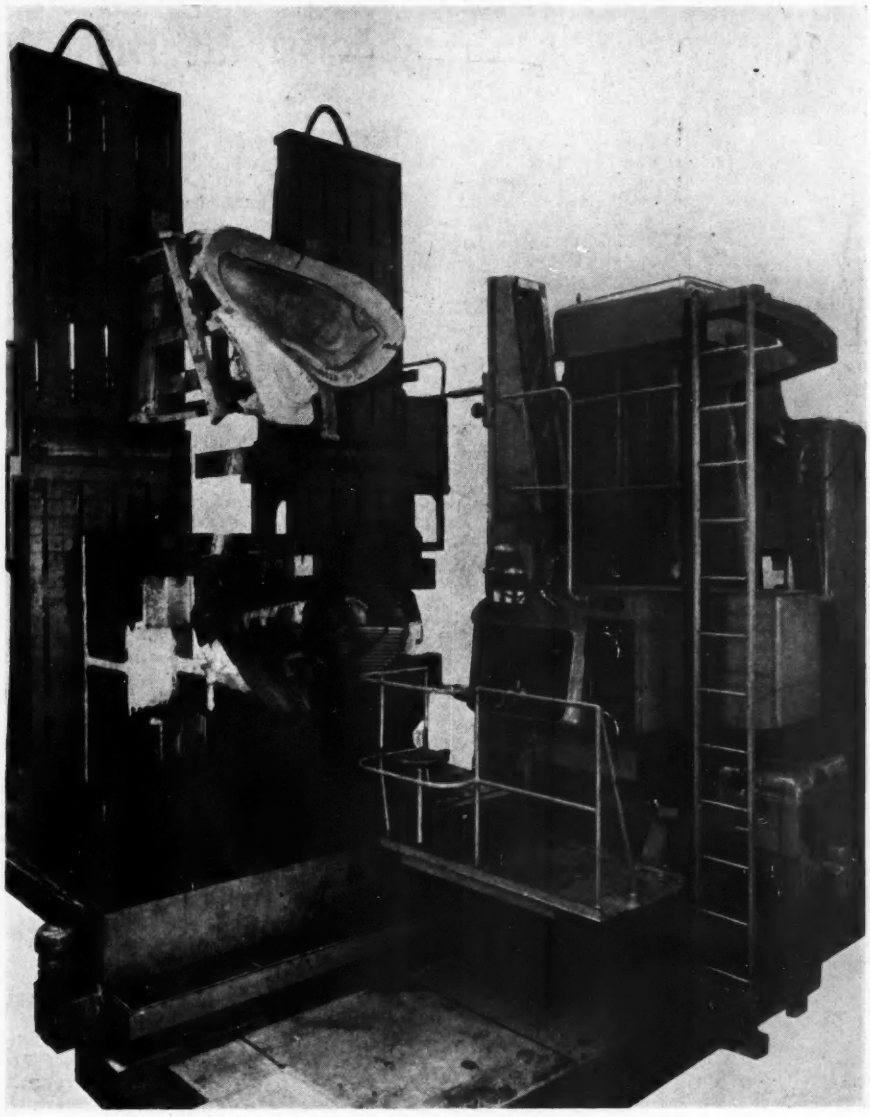


Fig. 3—Heyligenstaedt automatic copy milling machine

As can be seen on this machine, the pattern is mounted above the work blank on vertical plates on a fixed work table. The milling head with its superimposed tracer is mounted on ways on a saddle which is carried on a massive column on slideways at the side of the work table. All machining movements are motor-driven under the control of the tracer. The transverse and vertical movements of the tool are effected by operation of the spindle head saddle on the column and the head on the saddle, and the horizontal movements by traverse of the column along the slideways. Machines of this design can be built to mill work horizontally up to 200in, vertically up to 88in and transversely up to 32in. The spindle has a longitudinal adjustment of 10in in the head and its speeds range from 30 to 1200 r.p.m.

In the transverse direction the feeds range from 1·18in to 14·5in per minute and this feed drive, mounted in the vertical column, consists of a variable speed d.c. motor driving through a multi-disc electromagnetic clutch and a three-speed gearbox. The drives for vertical and horizontal feeds are situated in the bed slide and also consist of two independent variable speed d.c. motors driving through multi-disc electromagnetic clutches and three-speed gearboxes. The horizontal and vertical feed rates available range from 0·793in to 13·4in per minute. Each slide on the machine is fitted with dog-actuated limit switches, through which the traversing feeds and speeds, depths of cut, &c., can be preset to give an automatic working cycle.

From the grouped controls on the main control panel the operator can control milling speeds, feed selection, operational sequence, &c., and from additional push-button panels on the milling slide and column side, the operator can inch the machine when setting.

A number of radial drilling machines, shown by Hettner Bohrmaschinenfabrik F. Leber and Co., of Münstereifel, were fitted with an interesting preselector apparatus for feeds and speeds. The preselection mechanism is built into the machine and on depression of a switch the feeds and speeds for each operation are automatically engaged. The feed and speed combinations for each of a sequence of operations are set on a separate cabinet-mounted programme unit connected by a cable to the mechanism in the drilling head. In this programme unit there are two rows of complementary drums, one for speeds and one for feeds. When programming a sequence of operations each pair of drums is turned to the desired feed and speed rates for the operation. As each operation is completed on the machine depression of the switch automatically sets the machine for the spindle speed and feed of the next operation. An indexing dial on the programme panel is numbered to correspond with the number of changes and it can be turned to effect the speed and feed changes without use of the switch on the machine.

(*To be continued*)

British Association Meeting at Bristol

No. III—(*Concluded from page 413, September 16th*)

SEVERAL facets of development in civil aviation were discussed at the British Association on Tuesday, September 6th. The last papers of Section G were presented on the morning of that day, at two separate sessions, at the first of which Mr. P. G. Masefield presented a survey entitled "Recent Progress in British Air Transport," and Dr. W. J. Strang's paper, "Effects of Turbine Engines on Civil Air Transport Design," which was presented by Dr. A. E. Russell, was discussed.

Economics of Air Transport

Mr. Masefield summarised the economic background of contemporary airline operation, giving statistics analysing the income and expenditure of B.E.A. to illustrate his arguments. Much of this information was summarised in our issue of September 2nd, in a Seven-Day Journal note, which followed the presentation of a somewhat similar account by the same author.

The economic factors governing the successful commercial operation of an aircraft were explained in some detail in Mr. Masefield's lecture. This economic appraisal led to a consideration of the advantages of the turbo-propeller airliner. Operational figures for the "Viscount" were given, followed by estimates for the longer range "Britannia." The possibilities of the helicopter for shorter journeys was also discussed.

These remarks led on to what Mr. Masefield termed "the big issue in the next few years . . . the battle which is likely to develop over long-ranges between the very large jet aeroplane and the big turbo-prop aeroplane."

The basic elements of that battle, he said, appeared to be that, whereas the jet would be about 100 m.p.h. faster than the turbo-prop

Comparison of Long Range Turbo-Prop and Jet Aircraft

	"Britannia 300 LR"		"Douglas DC-8"
	"Proteus 755" turbo-prop	"BE.25," turbo-prop	"J.57" jet
Approximate date for North Atlantic service	1958	1962	1962
Maximum tourist passenger seating	96	96	125
Maximum payload for London-New York, lb	28,000	28,000	32,400
Cruising speed, m.p.h. ...	360	420	550
Maximum gross weight, lb...	170,000	170,000	257,000
Maximum fuel load, lb ...	68,000	68,000	120,500
Maximum sector distance with full fuel and reserves, miles	5,100	6,100	4,800
Relative cost per ton-mile ...	100	77	82
Representative journey time London-New York (Vs headwinds), hours	12	10	8

(550 m.p.h., compared with 450 m.p.h.) the turbo-prop could be made some 20 per cent cheaper for each ton-mile operated by aircraft of equal payload and range. And the question was whether there was a place for both the jet and the more economical turbo-prop or whether the higher speeds of the jet would attract so much of the traffic that the turbo-prop would be pushed out of the business on the long sectors. On the shorter ranges, where the higher speed of the jet could not be used effectively, the economics of the turbo-prop appeared likely to hold the field.

Over long ranges—such as the North Atlantic operation—an extremely interesting position was developing with, on the one hand, the British Bristol "Britannia," representative of the long-haul turbo-prop and, on the other, the Douglas "DC-8" and the Boeing "707," representative of the larger jets. Both these latter aircraft were very big indeed, accommodating 125 or more passengers in their tourist configurations, compared with the maximum of ninety-six passengers in the biggest version of the "Britannia" at present being produced. Neither of the American jets was likely to be available in non-stop North Atlantic form, however, for about six years to come. First deliveries of the "DC-8" in a shorter-range form, for U.S. domestic operations, were promised for 1959.

The "Britannia" would, it was hoped, be on B.O.A.C. North Atlantic services within the next three years. It would thus have a substantial lead in time, experience and reliability over the big United States jets. The "64,000,000 dollar question" was whether the big turbo-prop and its developments would be able to live in competition with the large jets when they eventually emerged.

A comparison of the relative characteristics of these aircraft outlined that most fundamental technical economic problem of the moment. The figures could be set out as in the table.

From these figures—which at this stage must be approximate—it could be seen that whereas the big jet had the advantage in speed the big turbo-prop was likely to be usefully cheaper to operate.

The "Proteus 755" "Britannia" would be substantially ahead of any contemporary piston-engined aircraft in comfort and economy with at least equal speed. The developed "Britannia" with the new Bristol "BE.25" engines, sixty of which engines were on order by B.O.A.C., seemed likely to show a 60 m.p.h. improvement in speed and a 23 per cent improvement in economy, compared with the "Britannia 300LR" with "Proteus 755" engines. If the "Britannia" were given a bigger body its economy could be improved a good deal more, without any significant change in speed.

Against that would emerge the new large United States jets, represented by the Douglas "DC-8" (125 passengers), the Boeing "707" (130 passengers), and also by a new "Convair" design of about equal size. They were all appreciably bigger than the "Britannia" and, being jets, were, as the table showed, likely to be rather more than 100 m.p.h. faster than even the more advanced "Britannia." But even with their increased size of payload they were not likely to get down to the same low cost as the developed "Britannia." Indeed, preliminary estimates made, on the most objective basis, suggested that the ninety-six-passenger "BE.25 Britannia" would be some 5 per cent cheaper per ton-mile to operate, compared with the 125-passenger "DC-8," which meant that, for equal sizes of payload, the turbo-props would be about 20 per cent cheaper per seat mile—a significant difference.

So we came back to the fundamental question. Assuming equal size of aircraft, would the turbo-prop be competitive with the jet, the turbo-prop taking three hours longer for the London-New York non-stop journey at a return fare which might be £40 cheaper on tourist fares?

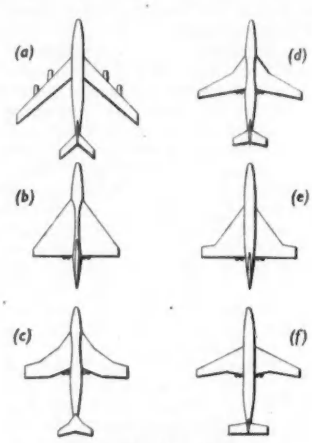
His belief was that there would be a place for both types of aircraft. The big jet would take the first class traffic at fares quite substantially higher than the tourist versions of the turbo-prop aircraft. The essential thing was that both types of aircraft should fly non-stop in all normal weathers. And the turbo-prop was likely to achieve a high regularity of non-stop operations on the North Atlantic a good deal sooner than the jet. The struggle between the rival forms of turbine power plant would be settled in the cold, hard light of airline competition and economics, with passengers' pockets and preference playing a dominant part in determining the technical answer. So the battle between the turbo-prop and the jet on the long ranges would develop with increasing intensity during the next decade. By the end of that time we might well be seeing revolutionary new types of aircraft with, possibly, nuclear forms of propulsion, entering the arena, Mr. Masefield commented.

During the course of the discussion following his lecture, Mr. Masefield said he believed that the answer for transport from city centre to airport would be found in the development of land transport. Personally, he would have liked to see the development of the monorail. He thought that those concerned in transport ought to look much more closely at the possibilities of an overhead slung railcar running on pneumatic tyres up to 180 miles an hour and bringing aerodynamic principles into play. He thought that this could give an answer which neither road nor present rail transport could give. Such a railcar could run over a modern arterial road slung on a single gantry with a single rail.

Problems in Civil Aircraft Design

Dr. W. J. Strang's paper on turbine engines for civil aircraft gave a concise résumé of the various classes of turbine engine—the basic "gas generator" and its variant the "spool" design, the turbo-jet, the turbo-prop, the by-pass engine, the ducted fan engine, and the "supercharged turbo-prop"—and explained their basic principles of operation. The advantages and limitations of these various classes of engine were then discussed, and Dr. Strang went on to give some technical background to the controversy of "turbo-jet" against "turbo-prop" upon which Mr. Masefield had expounded earlier. In the latter part of his paper, Dr. Strang dealt in greater detail with three design problems, namely, wing design, certain lift aids, and pressure cabin design.

Most of the big jet aeroplanes, bombers and transports, relied on sweepback, he noted, to postpone the bad effects of compressibility to a a high speed. Sweepback did this, but it brought



Wing planform design

with it a crop of additional problems connected with structural design, and with the stability and control of the aeroplane. A mass of literature, bewildering even to the expert, existed on these subjects, and new reports were being published all the time. The state of mind of the aircraft industry itself was revealed by the accompanying diagram, which showed a selection of the wing planforms that had been proposed for large turbo-jet aeroplanes. It should make us very humble, Dr. Strang contended. A class of twelve-year olds would produce similar results in half an hour, and the uninformed must surely assume that these shapes had been light-heartedly tossed off as the expression of their chief designers' artistic feelings.

In fact, five of the six had been sufficiently well supported to be built, at great cost. They were the outcome of thousands upon thousands of hours of hard thinking and hard testing. They had survived competitive, and sometimes bitter, technical argument and scrutiny; they all worked, and no one was sure which was best. The variations arose because the design requirements conflicted and different design teams had varied the emphasis.

One line of argument ran like this. A long, narrow wing—of high "aspect ratio"—was efficient, and sweep-back raised the permissible cruising speed. It helped the structural design to place the engines well out along the span to relieve the bending due to the wing lift, and a clever designer had found that by hanging the engines below the wing on stalks he could improve the flying qualities. The result was aeroplane (*a*).

Inspection of this suggested that it would be a much "cleaner" aeroplane if the engines were buried in the wing. This made the wing thicker, at least locally, and to preserve the high cruising speed the sweepback and the wing chord had to be increased. It was convenient to make the wing biggest at the roots, but then the engines, with their intakes and jet pipes, drive tunnels through the wing structure. This was serious

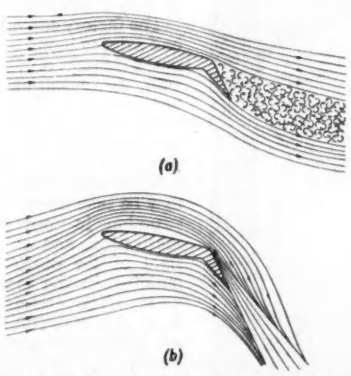
if the wing had a big span, but did not matter if the wing had a low aspect ratio and sharp taper. Such a wing was light in weight, but aerodynamically inefficient because of the small span. There was a way out. By going to the limit—aeroplane (*b*)—it became possible to dispense with the tail and make a beautifully clean delta-winged aeroplane with buried engines, no tailplane, and only a rudimentary body.

These were extremes. There was a range of intermediate solutions, while design (*e*) aimed at preserving the good features of the delta while improving the inefficiently small span.

That was the disappointing story of the attempts to design wings for aeroplanes flying a little slower than the speed of sound. For supersonic transports it was possible only to guess. The indications were that supersonic transports, to be economical, would have to be very fast indeed ; not just a little faster than sound, but three times as fast. They would cruise at least 10 miles high, and they would almost certainly have wings of small span. These wings, it seemed, should be either straight or very much swept—perhaps in the form of a narrow-angle delta like a paper dart. Those were guesses, but one thing was certain. Their speed would be wasted unless the terminal arrangements kept pace.

Lift Aids

It had been known for many years, Dr. Strang's paper continued, that profound changes in the pattern of airflow around a wing could be triggered off by injection of compressed air. The diagram herewith illustrates the air flow around a wing with a trailing edge flap deflected. The purpose of the flap was to increase the wing lift,



(*a*) Aerofoil with flap. (*b*) Aerofoil with flap and air injection.

Flow over aerofoil with flap

which it did ; but its effectiveness was reduced by the separation of an eddying wake from its upper surface, so that the gain in lift was less than theory predicted. That separation could be prevented by a jet of air over the top of the flap, as in the diagram (*b*), and the full theoretical lift increment might then be expected.

The next diagram showed that the air injection did indeed eliminate the loss, and added some additional lift as well. That additional lift was due to a phenomenon known as super-circulation, and might be understood by supposing that the air jet entrained additional air from the main airflow, and accelerated it. The well-known Bernoulli's theorem stated that when the speed of a fluid was increased its pressure fell. The result was that the pressure over the top of the wing was reduced because of the acceleration produced in the main airflow, and that accounted for most of the extra lift.

The two kinds of lift that air injection produced were quite different in character. The first kind, due to elimination of the air separation, was obtained quite economically, but it was limited in quantity. The second kind, due to super-circulation, was expensive but could be had in large amounts—several times the normal wing lift—if one was able and willing to pay the price in power.

One fascinating possibility was an aeroplane that could fly in its own slipstream. All aeroplanes with propellers gain additional lift because of the increased airspeed over the portion of wing behind the airscrews. It would be possible to design an aeroplane with lightweight turbo-prop engines, large flaps, and air injection which would be capable of hovering without the use of rotors. Control would be difficult, but such an aeroplane could be a rival to the transport helicopter. Immediate applications would be less ambitious. Air injection applied to an otherwise conventional aeroplane could be used to reduce the landing speed, and so improve safety and regularity in bad weather. It also reduced the speed required for take-off, but that did not always pay because the loss of engine power was usually enough to cancel the gains. The " supercharged turbo-prop " was an exception, because it had gas-generator capacity to spare for air injection.

Air injection was not the only way to control airflow. Strangely enough, sucking would do instead of blowing, and the turbine engine could be made to do this instead. Suction to improve lift used less power than blowing did, but it was less positive in action, and the possible gains were smaller. Suction could be used to reduce drag as well as improve lift, and, in fact, it offered all sorts of fascinating possibilities which had tantalised designers for years without ever quite coming into fruition.

If suction was more delicate than air injection, jet deflection was more brutal. It was nothing less than turning the main blast of the jet engines downwards. If the engines were sufficiently powerful the whole aircraft might be lifted bodily, but transport aeroplanes could not use such big engines unless they flew very high indeed, and then, of course, they could take off and land quite well in the normal way. As usual, moderation was more likely, and that took the form of deflecting the jets downwards at an angle, so that the weight was only partially supported by jet deflection. The take-off and landing were then normal in appearance, but slower than they would otherwise have been.

All these devices for making aeroplanes fly more slowly increased the difficulty of providing satisfactory control, and if that was not dealt with the pilot's job might get more difficult instead of becoming easier. Fortunately, air injection improved control effectiveness ; and that would probably be enough for all moderate applications of these new lift aids.

Pressure Cabins

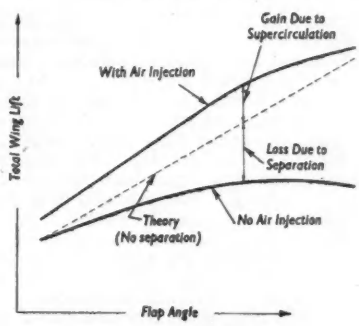
In his discussion on pressure cabin design, Dr. Strang noted that at a height of 8000ft the air pressure had fallen to 10·92 lb per square inch, about 74·2 per cent of its value at sea-level, and that was acceptable. Passenger-carrying aeroplanes flying higher than that were pressurised, and the cabin structure had to be designed to withstand the pressure difference. A difference of 10·92 lb per square inch was enough to maintain 8000ft cabin altitude at any height whatsoever.

All the long-range passenger aeroplanes in use to-day were piston-engined, and all were pressurised. The pressure difference of 7 lb to 8 lb per square inch was suitable for turbo-prop aeroplanes, and 8 lb to 8½ lb per square inch was sufficient for turbo-jets, so that turbine-engined aeroplanes were not very different in that respect from the latest types of piston-engined aircraft Nevertheless, the pressure cabin was an essential part of the turbine-engined transport and the associated structural problems had to be solved. Most people had heard of " high level " fatigue and knew that it was a disease to which pressure cabins were subject, so the author avoided those parts of the subject that had been widely publicised—for example, repeated loading in water tanks.

Metal fatigue was not novel either. It was not even new to aeroplanes, and there had been several disasters attributed to wing fatigue failure. It was reasonable to inquire if there were some fundamental difference between pressure cabin design and wing design which made one problem more acute than the other. The difference lay in the type of loading. A wing was designed to withstand the most extreme loading it was likely to encounter—for example, a severe manœuvre or a violent gust—and in normal use only a fraction of that strength was required. The normal stress, then, was small compared with the stress at the design load, and that provided some protection against fatigue failure. The biggest single contribution to pressure cabin loading was the pressure itself, and that was controlled, known, and occurred on almost every flight. Something quite close to the design load occurred regularly, and fatigue considerations dominated strength requirements. Wings experienced many fluctuations of load well below the design level, but pressure cabins had a regular cycle of loading near the design level, with small fluctuations super-imposed.

Pressure cabin structural design, then, was principally a matter of fatigue, and we knew that in securing a good fatigue life it was important to avoid structural discontinuities, e.g. notches, cutouts and changes in thickness. Such cutouts had been studied and it had been found that, by careful shaping of the holes and suitable reinforcement around the edges, their bad effect could be minimised. The success of these adaptations was measured by the " stress concentration factor," which was the ratio of the maximum stress in the neighbourhood of the cutout to the stress in the unperforated sheet. Perfect design, in this sense, would give a stress concentration factor of one. By preceding along those lines it was possible to design pressure cabins with a fairly high working stress and satisfactory fatigue lives. Meticulous attention to detail was required, and the consequences of an error in design, construction, or maintenance had to be thought out.

A suitable analogy was a pneumatic tyre. As normally inflated, such tyres leaked when punctured, but the damage did not spread. An over-inflated tyre might split or explode if punctured, and so might a normally inflated tyre if the initial damage were a sufficiently large cut. Pressure cabins might behave in either of those



Effect of air injection on wing lift

ways. A cabin of very efficient structural design was usually of the explosive kind, but might be acceptable with certain safeguards. If carefully maintained it should give a long period of safe service, and its eventual failure from fatigue could be forestalled by insisting on its replacement after a prescribed period of use. In addition, it was the practice to subject pressure cabins to a ground test periodically, in which a pressure greater than that used in service was applied, with the object, of course, of revealing any weakness that might have developed.

Without doubt, a high standard of safety could be obtained with that type of pressure cabin, and it should not be lightly condemned, the author contended. None-the-less, the more attractive idea of pressure cabins that would " fail safely," i.e. leak harmlessly, was the subject of an increasing amount of research activity. Cabins of that kind were heavier and that fact had to be accepted. Two questions were of great importance. The first related to the alloys to be used in construction, because the metallurgists were being asked to provide materials with properties that had not previously received sufficient emphasis—ductility, fatigue life and resistance to tearing. The second was the general question of just how to design structures which failed safely wherever the initial damage might happen to be located. Progress was being made with both questions, but the conclusions were not yet clear enough to be reported.

Structural Engineering Research

The second session of Section G, which was held on Tuesday morning, involved the presentation of papers by young engineers. The

first of them was entitled " The Effect of Leakage on Compression and Expansion in a Non-Flow Process," by Mr. D. L. Brook, and dealt with the mass variation, due to leakage, in an engine cylinder during a motored cycle.

The remaining papers were concerned with various researches into structural engineering problems. Mr. S. Henderson's paper, " Collapse Tests of Vierendeel Trusses," gave a comparison between an analysis by the simple plastic theory of a Vierendeel truss, and the results of tests on a model truss. The formation of plastic hinges was particularly observed in the model tests. Differences between theoretical and observed results were not greater than 6 per cent, and were attributed to the behaviour of the joints of the frame.

Two and three-dimensional studies of foundation stresses were given in Dr. J. E. Gibson's paper, " A Mathematical and Photo-elastic Investigation of the Stress Distribution Under Foundations." Here again a theoretical analysis was made and tests of actual cases were carried out three-dimensionally, using photo-elastic techniques, an alternative to the more usual " freezing " method being successfully adopted.

The final paper was " Constraint Effects in Box Beams," by Mr. D. Howe and Mr. K. H. Griffin. It dealt particularly with problems in the design of swept-wing structures, giving a survey of modifications to elementary stress distributions applicable to regions near built-in ends and concentrated loads.

This second session of section G, held on Tuesday morning, also included a performance of a film on the Snowy Mountains hydro-electric development in Australia.

" Man and His Machines "

In this brief account of the recent British Association meeting we have confined ourselves to a résumé of the engineering sessions. There were, of course, social events and visits to local places of engineering interest. Mention should also be made of the session held on the afternoon of Friday, September 2nd, under section L (education); it was entitled " Man and His Machines," and three papers were presented for discussion, namely, " New Concepts of Science and Advanced Industrial Techniques," by Sir Ben Lockspeiser; " Automatic Control in Industry and its Effect on the Schools," by Mr. H. Ree, and " Training of Technicians for the Automatic Age," by Dr. J. E. Richardson.

During this meeting Sir Ben Lockspeiser said that the increasing use of automatic machines would bring many problems, social, economic, and educational, in their train. Clerical workers in business offices and manufacturing industry accounted for about 10 per cent of the working population, and a gradual but substantial reduction in that proportion might be expected, particularly in large businesses and industrial concerns. In the manufacturing industries there would be less and less room for the unskilled person and in place of machine minders on the shop floor there would be required people who could take the pulse of machines and tend them. There would be a need for an increasing number of qualified design engineers, skilled maintenance engineers and production engineers trained to take advantage of automatic working. Research scientists, technologists and technicians would be needed in greater number than was considered necessary to-day.

Lastly, the march into the future would make a heavy demand on managements and the art of management would require strong infusion of technological experience. The fruits of full automatic production would be recovered, he considered, by a population substantially upgraded in skill and intellect, and the degree to which people were both willing and capable of responding to an advance of that character would set the limit to the pace and spread of the new methods of working.

Mr. Harry Ree said that the public schools had remained almost unaffected by the greatly increased demand for technologists and scientists. Generally speaking, the whole bias of influential opinion in the public schools had firmly directed the clever new boy towards the classics and the humanities. Even for those who took up science, the respectable career was medicine, and engineering and technology were hardly considered as possibles. The very high post-war birth-rate would mean that a far greater number of young people would be leaving the schools each year in the late 1960s, and that would mean a larger number of scientists available.

Dr. J. E. Richardson said that hitherto the task of the technical colleges had been broadly that of teaching men the technology of the work they were engaged in, but now it was to become to teach men to understand and maintain the " gadgetry " behind the machines that did the work they once did. The colleges would have to meet a changing emphasis and for that they would probably need large laboratories for pilot plant, smaller laboratories for specialised training, closer integration with industry (by operating sandwich courses, by generous exchange of staffs between college and industry, and by industrial representation on governing bodies of colleges), salary scales adequate to retain the best men, and a more rational scheme of technical organisation.

Factory Structure in Precast Concrete

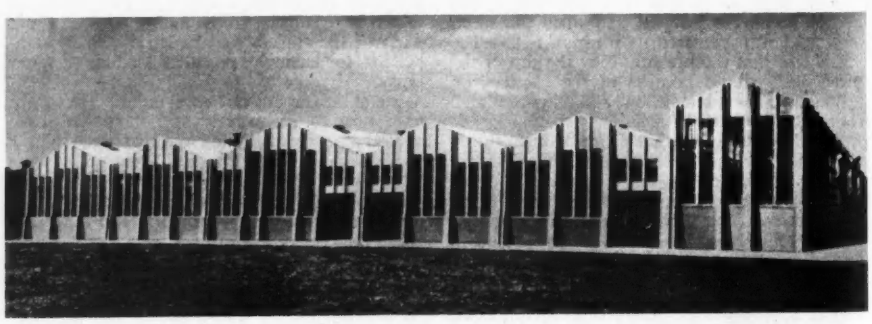
WE illustrate on this page a factory structure at Nuneaton, which has recently been erected by Beecham Buildings, Ltd., of Shipston-upon-Stour, Warwickshire. The building covers 200,000 square feet and is built of precast concrete. It will be used by Sterling Metals, Ltd.

Readers of THE ENGINEER will doubtless recall the various examples of structural precast concrete which we have described over the past few years. They demonstrate the increasing use of this form of construction, and the tendency to employ it for the heavier structures as well as for comparatively light standard buildings, a tendency which is particularly illustrated by the present example. In fact, the heaviest example of a precast concrete structure of which we are aware is the turbine house at Acton Lane power station, described in THE ENGINEER of February 1, 1952. There were, however, certain differences in the technical approach to that structure and to the factory described here. The Nuneaton factory was built from precast elements made in the firm's factory and transported to the site, and the standard system of construction, used by Beecham Buildings, Ltd., for its more normal, smaller buildings, was retained as much as possible. The building was completed in a period of twelve months.

Erection of a factory building from precast concrete elements. The bay shown here spans 34ft and is 40ft high at the eaves. A 5-ton crane is carried about 27ft above the floor

The factory comprises half a dozen bays, covering a length of 500ft, with an extension at one corner. On the eastern side there is a tall bay, spanning 34ft, and rising to a height of 40ft at eaves level. This bay may be seen under construction in our first illustration, and on the right of the completed building in the second view. The remaining bays each span 50ft and are 28ft high to the eaves, except for the central bay of the five, which spans 67ft. Travelling cranes of 5 tons capacity are carried, 18ft above floor level in each bay. The internal columns are spaced at 33ft 4in centres, with alternate roof members carried by the crane rails, but the exterior columns carry the roof members directly and are at 16ft 8in centres. The building was designed according to the code of practice C.P. 114.

The heaviest precast members in the structure weighed about 6 tons and none of them exceeded 40ft in length. The crane beams and certain



The completed factory covers 200,000 square feet. The tapered columns shown here resist side loads due to wind, and, on the other side of the building, they take the side thrust from the arched roof

column units were the heaviest ones. Our first illustration gives a good idea of the structural design. The roof is a three-pinned arch, formed by two L-shaped members. At the centre there is a crown casting ; each L-shaped half-arch is rounded to fit into a cup-shaped bearing in the crown casting, thus forming, in effect, a pin joint. A layer of felt is placed between the concrete surfaces here, as at other "pin" joints in the structure, and the crown piece is held to each half-arch by a bolt, set in mastic, which does not interfere with the "pinned" property of the joint, but resists any upward load, such as might be caused during erection.

It may be seen that the vertical legs of the arch members are placed in channels formed in the upper parts of the columns. They are simply supported in half-round bearings just above the level of the crane beams. The arch thrusts of adjacent spans balance against each other, but in the end spans the columns are tapered, thickening at the base, with reinforcement on the tension side, to resist the side thrust.

The outer walls are carried on beam footings between the columns, and the weight of the columns, walls and superstructure acts with the thrust from the roof frame to produce a resultant much nearer to the centres of the columns than it would be if only the thrust and loads due to the roof frame were considered. The foundations, therefore, although they project further outside than under the floor of the building, are smaller than would otherwise be necessary.

Normally, a "boxed-out" space is left in the foundation slab to take the column, with a "bearing block" in the centre of it. The block is simply a concrete casting with a cup-shaped depression, which mates with the half-round bearing on the column base, felt again being interposed. With the column placed in position any necessary reinforcement is placed, and the whole assembly concreted. The columns are in one piece in the lower bays, but have a site joint in the tall bay. In that case the lower column member has a deep groove formed in it for its full height, and the reinforcing bars placed in the base slab extend throughout the length of this groove to lap with the bars from the upper column element. Generally, a similar system of jointing is used where continuity is needed, with generous grooves left in the precast member near the joint, so that continuity steel can be placed and the joint completed with in-situ concrete. Other joints are completed with neat cement grout. Other points which may be noted from the illustration are the brackets formed on the columns to carry the crane rails, and some of the other kinds of precast elements, most of them standard, needed for the complete building, such as the gutter members, the roof purlins, and the mullions.

The tapered columns of the outside walls, which, it will be recalled, are proportioned to resist the horizontal thrust of the arch roof, are also repeated again along the ends of the building. Here they serve to provide wind bracing. In erecting the structure one end wall is first completed, and then subsequent bays are braced to it while erection is proceeding.

Work in the taller bay also included the construction of hoppers, which were largely precast, and of a gantry commanding the adjoining stock yard. The building is generously glazed, and has aluminium sheeting on the roof. A wall 8ft high was built round the perimeter with cast-in-situ lightweight concrete, and precast work was then employed above it.

Automatic Overdrive Transmission

WE have been afforded an opportunity to study the automatic overdrive recently introduced by the Ford Motor Company Ltd. 88 Regent Street, W.1, on its "Zephyr" and "Zodiac" models. The overdrive gear is a product of the Borg-Warner Corporation, which has manufactured over 2,000,000 similar units during the last twenty years.

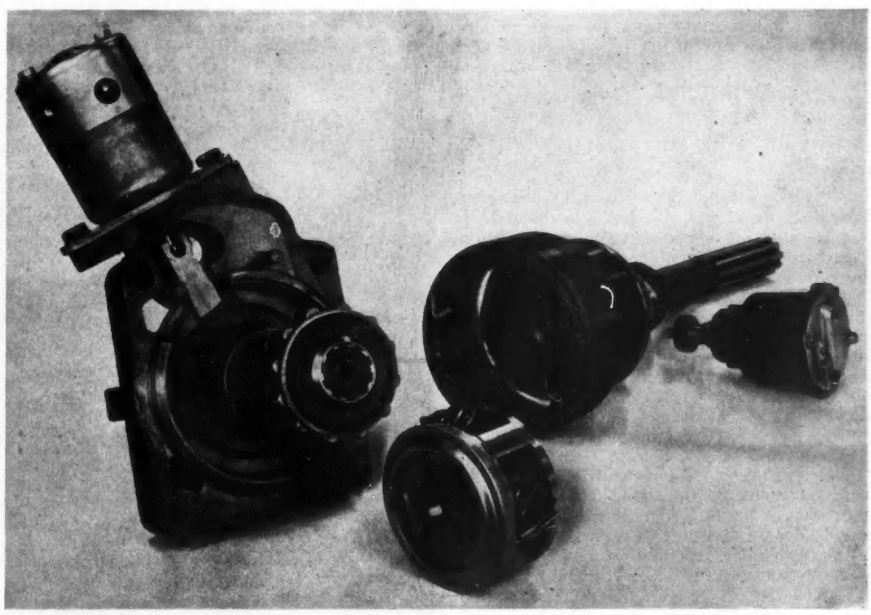
The principal units of the gear, which is in effect a two-speed box with ratios of 1:1 and 0·7:1, and is housed in the rear extension of the gearbox, can be seen in our illustration. The main shaft of the normal three-speed gearbox runs freely through a helically toothed sun wheel and splines on its rear end drive the planet carrier (removed in the figure) and a freewheel. Both the ring of teeth seen on the front face of the carrier and the teeth of the three planets mesh with the sun wheel, but as can be seen the teeth of the latter are interrupted so that at the appropriate axial position on the sun wheel the carrier—and therefore the mainshaft—can rotate about it. The planets mesh with the teeth visible within the output shaft, which also carries a hardened steel ring into which the rollers of the freewheel drive. The freewheel has twelve rollers about a cam, located by a cage spring-loaded towards the drive attitude : any reversal of torque overcomes the spring and moves the rollers down the flanks of the cam.

The teeth of the sun gear fit into a control plate, around which are eight teeth which can be engaged by a pawl, and sprung on to a shoulder on the face of the plate can be seen a C-shaped member acting as a baulk ring. Not shown in the illustration is a sliding selector shaft with a fork engaging the collar on the sun gear : this shaft passes closely to the right of the pawl, and is reduced in diameter to allow the pawl to drop only when the shaft is in its forward position. Above the pawl is a solenoid, spring-loaded "out," which, when energised, pushes the pawl inward through another, lighter, spring. Geared to the output shaft is a governor controlling an electric switch.

The selector shaft abuts the first-reverse selector shaft, and whenever reverse is engaged, or whenever the driver chooses to lock out the unit, the fork moves the sun gear back until its teeth mesh with the planet carrier : the entire planetary system then revolves together, and normal direct drive exists. When the shaft is moved forward, the sun gear will not be locked into the carrier, and the pawl will not be blocked up. In this condition, no power will pass to the pinions, since the sun is free, and the freewheel will take up the drive : the main shaft speed will be free to drop below output speed, in which event the pinions will impose upon the sun gear an even lower or possibly negative speed. Once the governor driven from the output reaches its cut-in speed, which will be at 31·5 m.p.h. on a Ford installation, the solenoid is energised, and the pawl moves inward under spring pressure. If the input speed is either less or more than 0·7 of output speed, the pawl will be intercepted by the baulk ring. When the engine is accelerated to take up the drive or allowed to cease driving, as the input passes through a speed of 0·7× output the sun gear comes to rest and changes direction: the baulk ring clasping the sun gear control plate moves and the pawl drops through and engages the teeth of the control plate. The sun gear is now locked : the planet carrier and output ring are then geared together with a ratio of 0·7:1 and the output over-runs the freewheel.

The solenoid withdraws the pawl either when the governor cuts out, at about 25 m.p.h. in this application, or when the throttle pedal is forced hard down. In the latter case, since the pawl would be exerting a resisting torque of about 30 per cent the engine torque even in top gear, the ignition is cut until the pawl moves ; this may cause three or four power strokes to be missed. Once the pawl is retracted, it is possible for the driver to draw back the selector shaft, but the sun gear cannot engage the planet carrier when the car is freewheeling. It will be seen that the changes are made with no clutching or braking actions, and the only frictional effort is the grasp of the baulk ring on the sun gear control plate. The virtue of the governor being geared to output speed is that the speedometer gives the driver ready assurance that the freewheel is selected and that gear changes can be made clutchless.

A drive in a "Zephyr" with overdrive proved that, due to the baulk action, changes into overdrive were shockless. The only time when changes down were conspicuous was on slowing to 25 m.p.h. when over-running the engine in second; as the freewheel became effective, the car ceased to check under the engine drag, and the engine speed fell considerably. This was, of course, the result of the governor being driven from the output shaft ; if it were driven at engine speed, it would require a ratio of cut-in to cut-out speeds of at least 1·45:1, and another disadvantage would be that a change down from, say, third might engage either direct or overdrive second. Below cut-in speed all synchromesh gear engagements were made without using the clutch : with an engine possessing torque enough to accept direct drive at 30 m.p.h., it was easy to drive without using the clutch except for starting. Since the freewheel is lightly spring-loaded into engagement, it is not possible to engage first without synchronising engine and transmission speeds.



Automatic overdrive transmission. The baulk ring has intercepted the pawl, as when the engine is driving and the free-wheel engaged. The cam inside the freewheel cage can be seen and also the roller track within the output annulus.

French Electric Power Developments

DETAILS have been received from Electricité de France of installations put into operation in the course of last year. These have increased the total production by 1100 million kWh for a year of average rainfall. The power stations of Randens (Alps), Montpezat (Massif Central), and Pragnères-Cap-de-Long (Pyrenees), (THE ENGINEER, March 18, 1955, page 372), have been put into service, as well as three other and smaller stations at Le Chevril (Alps), Campan and Les Echarts (Pyrenees). A fourth set of 80,000 kVA has been installed at Malgovert, and a second 100,000kVA set at Bort.

Fig. 1—Pragneres power station showing penstock with pumping station for storage of water from the left bank catchment in the Cap-de-Long reservoir

As regards steam equipment, the only addition has been a 50,000kW set at the Nantes-Cheviré station which had been opened the year before.

Some supplementary work of minor importance was also carried out in other steam and hydro-electric power stations, and there were substantial expansions of the distribution system.

PRAGNERES-CAP-DE-LONG, AND LUZ II

Of the newly completed hydro-electric stations, the Pragnères-Cap-de-Long scheme has been described in our issue of March 18 (page 372). It may be recalled here that the power station is situated at 906m level in the upper valley of the Gave de Pau between Lourdes and Gavarnie (Hautes Pyrenées). Water from the left-bank tributaries of the Gave is diverted and reaches the power station through a 2km penstock. Since there is not enough storage available on the left bank to accommodate the water which accrues in the spring, the surplus is allowed to rise to the intake level of 1690m in a similar penstock on the right bank, Fig. 1, and is pumped into the reservoir of Cap-de-Long at 2160m level. This reservoir of 67,000,000 cubic metres capacity is principally fed by a system of conduits 40km long; it stores waters equivalent to one-third of the total hydraulic power of the French Pyrenees. The main pumping station, installed on the cliff-face, has a capacity of 50,000kVA. There is another pumping station at La Glaire which helps to feed the reservoir.

Equipment at Pragnères consists of two horizontal 80,000kVA sets, each powered by two single-jet Pelton turbines. These units of 100,000 h.p. are, together with those at Malgovert, the most powerful horizontal sets in France. Downstream of this station and with a difference in level of 236m is the Luz II project which it is hoped will come into operation at the turn of the year. Building at Pragnères began in July 1947. It was necessary to construct eighteen cableways, over 3½km of funiculars, and 33km of new roads or tracks. It took seven to eight weeks every year to clear the snow from the site of the dam. Concreting could take place only during 100 days each year, so that the placing of the 270,000 cubic metres of concrete for the 100m high arched dam had to be spread over four seasons from 1950 to 1953.

Pragnères and Luz II will have a combined capacity of 390 million kWh, with pumping requirements amounting to 40,000,000kWh, three-quarters of which will be off-peak.

MONTPEZAT

The principal reservoir of the Montpezat power station is formed by the 108m deep Lac d'Issarlès, an old volcanic crater. Two tributaries of the Loire, the Veyradère and the Gage, as well as the Loire itself, have been dammed and connected by 20½km of tunnels with the lake and with the power station across the Cevennes watershed. From a total catchment area of some 200 square kilometres, 220 million cubic metres of water per annum are obtainable on the average, and utilised over a head of 634m serve to produce 300 million kWh, the reserves themselves corresponding to 56,000,000kWh. The principal dam is the one at La Palisse on the Loire, this arch dam being 60m high and 176m along the crest, with a volume of 30,000 cubic metres. The Gage dam (Fig. 2), is 47m high with a 143m crest, and 4500 cubic metres of concrete. It is exceedingly thin (3m at the base, and only 1·3m at the crest) and is regarded as a pioneering design.

The tunnels consist of two principal sections, both completely lined. Of these the first connects Lake Issarlès with the Gage and La Palisse dams, and is 4·3km long and 7·4 square metres in section. The second starts at La Palisse and ends at the surge shaft, a length of 13km. It has a cross-section of 9·2 square metres, and is clad for 600m upstream of the surge chamber with steel sheeting 12mm thick. The surge shaft is 111m deep and measures 3·5m in diameter. Non-flooding expansion chambers are provided at top and bottom. The pressure penstock is formed by a steel-lined duct of 46 per cent slope, 2·3m in diameter, and 1473m long, the lining varying according to the water pressure and rock conditions, from 12mm to 35mm thickness. An access shaft at the half-way point and a cableway had to be provided for construction purposes.

The power station (Fig. 3) is completely underground and has a length of 60m, width of 13·5m and a height of 27m. Built for a total flow of 22 cumecs it has two units of 58,000kVA each, each consisting of two horizontal double-jet Pelton turbines on either end of the alternator. The tail-race is 2700m long, and delivers the water into the Fontaulière, a tributary of the Ardèche.

Access to the power station is through a tunnel and a bridge over the Fontaulière, both inclined at a slope of 55 per cent. The access gallery also contains the cables which conduct the output at 15,000V to the 220,000V transformers on the right bank of the Fontaulière on the Soubeyrols plateau, where are also situated the control building and ancillary services.

The whole of this project, which had been under

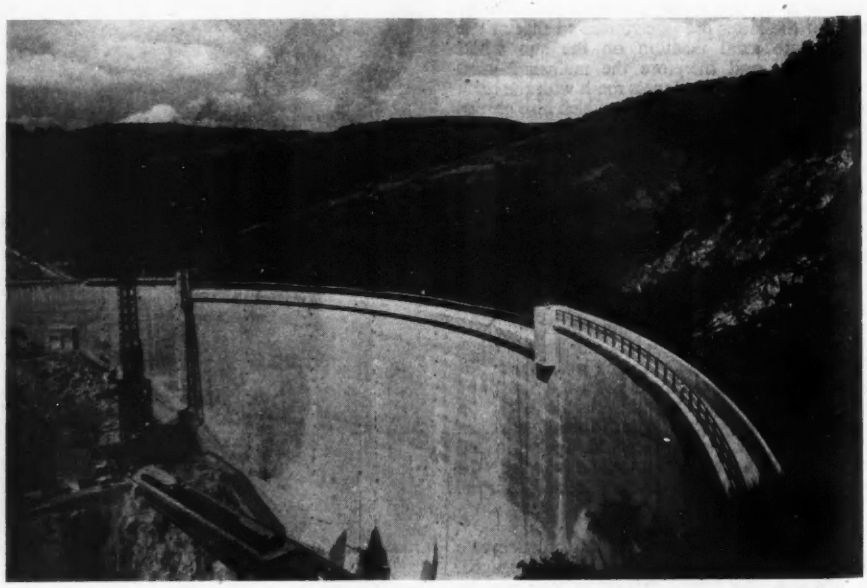


Fig. 2—Moulin de Peyron dam on the River Gage, is a thin arch dam 47m high, with a thickness at the base of 3m and at the crest of 1·3m

Fig. 3—Underground power house at Montpezat. The two 58,000kVA alternators are driven by Pelton turbines from each end. Head, 634m ; flow, 11 cubic metres per second per set

construction since 1950, was put into service during November 1954. One of the chief difficulties was the broaching of the Lac d'Issarlès which was achieved under a head of water of 40m without previously emptying the lake.

Isere-Arc

The Isère-Arc project is situated below the Brevières and Malgovert power stations and makes use of the regulated flow from Tignes reservoir. Diverted at 471m altitude, downstream of Moutiers, the Isère is returned to the Arc at Randens at 319m altitude, near the junction of the two rivers. The Randens hydro-electric station thus uses waters from a 1575 square kilometres catchment, yielding at an estimate 450 million kWh in the average year. The head is 152m, and the flow 100 cumecs.

The barrage is a structure 70m high with two openings of 10m width, each fitted with two gates at the top and two at the bottom. An intake culvert just under 2½km long, consisting of reinforced concrete rings of 6·4m diameter cast on site, is followed by a tunnel of 13½km length, of which nearly 3km run parallel with the Isère, and the remaining two pass under the Grand Arc massif. This section constituted the most difficult portion of the undertaking, being a tunnel of 43 square metres section (gross), with a maximum overburden of 2000m and totalling in length, if the adits at each end are included, some 11,700m. The conditions were such as had not been met with since the Lötschberg tunnel was completed nearly fifty years ago. The tunnel was pierced mostly in full section in under four years, thanks to the employment of the most up-to-date means for drilling, loading, and transporting the rock. It is fully lined and the concreting was carried out using telescopic shuttering. In spite of the fact that bad rock at the downstream end necessitated a return to the traditional method of first excavating a pilot heading, the average progress was 9m to 10m a day, with a maximum of 12m a day and a monthly peak of 274m.

The surge chamber is 50m high and 18m in diameter, with two expansion chambers at the top. Its total volume is 21,500 cubic metres and it has to compensate the movements of a mass of water of 500,000 cubic metres. Two vertical penstocks of 120m height have been constructed, each 3·7m in diameter, which deliver the water to the power-house (Fig. 4). This is situated entirely underground and required an excavation 101m long, 18m wide and 28m high. The access tunnel has a length of 250m. Equipment consists of four vertical Francis turbines of 44,000 h.p. each, coupled to 36,000kVA alternators, and two 72,000kVA, 10·3/150kV transformers, which feed the outgoing 150kV cable. The tail-race channel comprises an underground portion of 50 square metres section, together with an open channel 1105m long, which has a mean section of 295 square metres and is clad with prefabricated concrete slabs.

Begun early in 1951, the work on the underground station was pushed forward rapidly, concreting being completed by the end of the following year. Installation of equipment was carried out during 1953 and 1954, the first two units being ready when the tunnel was completed in March, 1954. All four alternators were in operation by October of last year.

Distribution

During the year 1954, 628km of 225kV transmission lines were completed, as well as 276km for 160kV and 378km for 90kV. The number of substations put into service was 434, with a total transformer capacity of 1862MVA. One of the most important works carried out was the completion of a new 225kV line between the interconnecting substation at Pratclaux, and the substation at Marmagne, near Bourges, a distance of 278km. It is at Pratclaux that the energy derived from the power station of Montpezat is fed into the grid. The new high-voltage transmission line has conductors of 600 square millimetres section, compared with the 411 square millimetres previously employed for this voltage. A new design of pylon was also used for the first time, which is some 40 per cent lighter than previous types. This development is the most marked result of the present French research into the possibilities of reducing the weight of equipment, and came after two years of studies and model tests at the laboratories of the Electricité de France, and full-scale tests at the works of one contractor. Very heavy transmission cables have been installed on a trial basis on the short section Bollène-Bagnols. Their use is claimed to be justified by the reduction in losses which is achieved.

Another 225kV line has been constructed between Randens, in the Maurienne, and Mions, a suburb of Lyon, in order to distribute the output from the Isère-Arc hydro-electric scheme. The switching station at Mions, which was completed in a particularly short time, is of especial interest, since it is based on a novel principle of "phase mixing," for which a patent has been obtained by Electricité de France. It is stated that these and other improvements have halved the cost of such a substation.

Another 225kV line has been completed from Creney (Troyes) to Revigny and Souilly (115km), and an existing 150kV line from Souilly to Landres has been changed to operate on 225kV. This reinforces the connection of the great iron districts in Lorraine with the important interconnecting point Creney, at which the lines from the Alps, the Rhine and the Paris region converge.

In the south the first part of an interconnection between the Pyrenees and the Alps has been put into service in the shape of a 150kV line between Nentilla and Béziers, through Perpignan (141km), and Jonquières and Salon (56km). It is intended to complete the section Béziers-Jonquières this year.

Lastly, in the west, where over the last few years important 90kV lines have been completed between Melle and Ruffec, St.-Florent (Niort) and Faymoreau, and St.-Florent and Saintes, totalling 140km, there have been put into service two substations, one at Holque (Flandres) and the other at Arnage (near Mans), where, by means of 225/90kV transformers of 70MVA capacity long-distance supplies are fed into the local 90kV networks. Near Orleans an additional 220/90kV, 70MVA transformer has been installed at Chaingy, with another one of 220/150kV and 100MVA capacity at Etupes in the Sochaux-Montbéliard industrial region.

Some 33km of three-phase underground feeder cables have been installed in the Paris region, of which 14km are pressurised with nitrogen. These employ three different techniques, none of which has been used in France before.

During the course of 1954 the 63kV, 45kV and 30kV networks were extended by the addition of 1000km of lines,and fifty substations with a total transformer capacity of 1000MVA. This is about the same increase as occurred the year

Fig. 4—Randens power house. Four 36,000kVA sets with vertical Francis turbines are installed, which feed two 10·3/150kV transformers. Head, 152m ; flow, 25 cubic metres per second per turbine. On the right may be seen the refrigerators for supplying coolant. The entire installation is underground

before. Medium-tension distribution networks were extended by 4000km, and low-tension systems by 1400km. Some 1000 substations were also constructed. Compared with 1953, the increases are about 60 per cent for the network and 40 per cent for the substations.

Lack of funds during the period 1947 to 1953 has hampered the development of distribution systems. Normal expansion was only possible in respect of the 63kV, 45kV and 30kV grids. The overloading of the medium and low-tension distribution systems could not be reduced and the work actually carried out served only to maintain existing conditions without effecting any improvement. The year under review therefore marks an important turning point in this respect.

Work which has been going on in South-Eastern France to convert from 25 c/s to 50 c/s is nearing completion, distribution at 25 c/s having been reduced from 50,000,000kWh in January to 16,000,000kWh in December.

Commercial Television Transmitters at Croydon

THE London television station of the Independent Television Authority was officially opened by the Mayor of Croydon on September 13th, in anticipation of the start of normal programme services on September 22nd.

The station was designed by Marconi's Wireless Telegraph Company, Ltd., in collaboration with the Independent Television Authority and the complete television equipment was built by the company. Work on the site was started in February last and the equipment was installed and in operation within seven months. By September 4th test signals were being radiated from the 10kW vision transmitter and the 2½kW sound transmitter.

The outputs from these transmitters are fed into an eight-stack aerial array (Fig. 2), The existing transmitters (Fig. 1) are prototypes and the installation will be augmented in the near future by two more Marconi transmitters, which will be standard production versions having approximately the same outputs as the initial equipments.

The production version of the Marconi, Band III, 7½/10kW vision transmitter, which will be installed at Croydon, consists of a 2kW transmitter (type BD.357B), together with a Band III amplifier (type BD.360). The transmitter is housed in four standard cubicles, and the amplifier in three, all of which are bolted together to form a continuous front. The complete transmitter is designed to give a peak output power of approximately 10kW under vestigial sideband conditions, at any chosen channel in the upper frequency band of 170 to 216 Mc/s, using the British standard 405-line system. Air cooling is used throughout and the general design of the transmitter is based on the policy of generously underrunning all components and valves. A C.R.T. monitor is incorporated for waveform examination. Push buttons are provided on the transmitter control panel for normal day-to-day operation of the transmitter, which may thus be brought up on power from the control desk. The voltage and feed of the final amplifier are metered ; a black level control and calibrated input attenuator are also provided on the control panel.

The BD.357B transmitter has crystal controlled drive circuits : the crystal itself is oven controlled and operates at a sub-multiple of the output frequency. Long-term stability is stated to be better than 0·0002 per cent, which permits offset carrier operation of two adjacent transmitters on the same channel. The crystal oscillator, together with associated frequency multipliers and stabilised h.t. supply, form a complete unit with an output of approximately 15W at the operational frequency.

The first and second r.f. amplifiers consist of ACT-25 triode valves working in single-ended grounded grid circuits, using coaxial lines as circuit elements. The final (modulated) amplifier contains an air-cooled tetrode in a single-ended coaxial line circuit.

The output signal from the control desk is bridged across the input of two units, namely, a clamp pulse generator and a correction unit. The clamp pulse generator produces a clamping pulse of 2V amplitude, which will remain correctly timed in the presence of noise pulses on the incoming signal, positive or negative going, up to 1½ microseconds duration. In the correction unit the synchronous pulses are stretched, clipped to standard level, and pre-correction is applied to compensate for transmitter non-linearity. Fine gain control is incorporated. Signals are clamped by pulses from the clamp pulse generator, and the output is approximately 1·5V D.A.P. (Double-Amplitude Peak) to the next stage, the pre-amplifier, where the signal can be increased to approximately 50V D.A.P. Since the input is correctly clamped, the black level is maintained in the succeeding stages by d.c. restoration. Coarse and fine preset gain controls are provided on this unit.

Fig. 1—The control desk and window overlooking the transmitter hall of the Independent Television Authority's station at Croydon

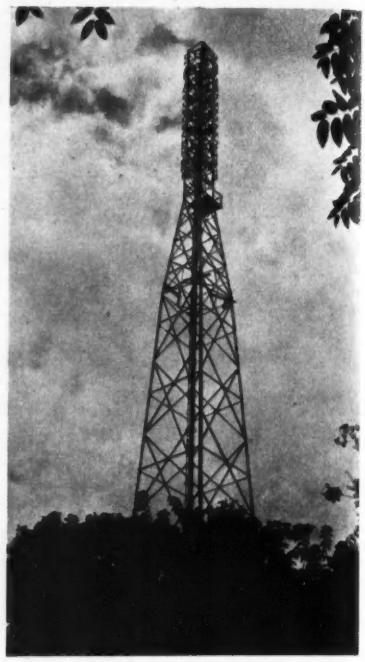


Fig. 2—Eight-stack aerial array and tower at Independent Television Authority's Croydon station

A signal is obtained via a probe in the aerial feeder, rectified and fed to the final clamping and black-level-feedback unit. The amplitude of the synchronous pulse in the signal thus derived is used to maintain the black level constant. The signals are also clamped by pulses from the clamp pulse generator. Should a fault occur in the feedback path, the feedback control may be switched out of operation.

The final amplifier and modulator is fed from the final clamping stage through an input cathode follower, the whole circuit being directly coupled to maintain the constancy of black level. A cathode-follower feeds a normal shunt regulated amplifier, followed by a shunt-regulated cathode follower stage, to supply the large reactive current demanded by the stray capacitance appearing at the modulation terminals of the amplifier. A peak modulation limiter is included.

The modulated output of the 2kW transmitter is fed to the input of the BD.360 amplifier, which consists of a BR.1106 single-ended air-cooled triode operating in a coaxial line circuit to raise the power output level to approximately 10kW peak.

Proposed Line of London-Yorkshire Motorway

THE proposed line of the first 53 miles of the London-Yorkshire Motorway, from the future St. Albans By-pass to a point near Rugby, has been announced by Mr. John Boyd-Carpenter, Minister of Transport and Civil Aviation. Plans will be available for inspection at the offices of the local authorities concerned. The estimated cost of the motorway is £15,000,000. The section from the north end of the St. Albans By-pass, south of Luton, to Watford Gap, near Ashby St. Ledgers, Northamptonshire, will form the first part of the proposed London-Yorkshire Motorway and the spur from Watford Gap to a point on the London-Holyhead Trunk Road (A.45), near Dunchurch, will provide a link for Birmingham traffic. There will be dual carriageways on the A.45 from this point to Birmingham and the villages of Dunchurch and Meriden will be by-passed. There will be six flyover junctions, forty-six bridges over public roads, eight railway bridges, three canal bridges, five river bridges, and many bridges for public paths, private and agricultural access along the route.

Electric Furnaces for Spheroidising Steel Tubes

PARTICULARS have been received from G.W.B. Furnaces, Ltd., Dibdale Works, Dudley, Worcs, of a batch of the firm's electric furnaces which has been supplied to Tubes, Ltd., for the purpose of spheroidising high-carbon/chrome-steel tubes used for the manufacture of ball races.

This spheroidising process is of considerable importance in the fabrication of the steel for ball bearings and ball races. The usual composition of this steel is as follows :—carbon, 0·9 to 1·1 per cent ; manganese, 0.4 to 0·6 per cent ; chromium, 1·1 to 1·5 per cent. Such steel is subjected to a selected temperature cycle, usually within or near the transformation range in order to produce a suitable globular form of carbide which improves its machinability, facilitates subsequent cold working and imparts a desirable structure for subsequent heat-treatment.

Spheroidising methods frequently used are as follows :—(1) prolonged holding at a temperature just below Ae_1 ; (2) heating and cooling alternatively between temperatures that are just above and just below the change point Ae_1 ; (3) heating to a temperature above Ae_1 or Ae_3 and then cooling very slowly in the furnace or holding at a temperature just below Ae_1 ; (4) cooling at a suitable rate from the minimum temperature at which the carbide is dissolved, to prevent reformation of a carbide network and then reheating in accordance with (1) or (2).

The furnaces illustrated are part of the installation of five batch units supplied to Tubes, Ltd. Each furnace is heated by nickel-chromium strip resistance elements situated in the roof and hearth of the heating chamber, a panel of heating elements also being fitted to the inner face of the door in order to counter end heat losses and assist in obtaining a high degree of thermal uniformity throughout the chamber length. The chamber is 6ft wide by 2ft 3in high to the arch springer and 31ft 6in long. It is suitable for accommodating a maximum charge of 6 tons of steel tubes ranging from 1⅛in to 5½in diameter up to a maximum length of 30ft.

The maximum rating of 420kW provided is arranged in four equal, independently controlled, heating zones distributed evenly along the length of the furnace. A transformer is provided which enables the element voltage to be reduced so that, if required, the input to the furnace can be reduced to 50kW. This rating reduction is effected during the long soaking periods after thermal equilibrium has been obtained throughout the charge. The sequence of heat-treatment carried out in these particular furnaces is as follows :—Charge loaded into furnace standing at 600 deg. Cent.; raised to 780 deg. Cent. in 3·5 hours ; held at 780 deg. Cent. for four hours ; cooled to 720 deg. Cent. in six hours ; held at 720 deg. Cent. for four hours, and cooled to 600 deg. Cent. in eight hours. As a general rule, the cooling rate never exceeds 20 deg. Cent. per hour.

The comprehensive system of temperature control required is effected by use of a Cambridge programme controller working in conjunction with three Cambridge non-indicating potentiometric controllers, while a four-point Cambridge recorder gives a positive and permanent check on thermal conditions along the furnace length throughout the heat-treatment cycle. A set of excess temperature safety contacts fitted in the recording instrument act as a protective device in case of accidental overheating. In addition to the careful zoning of the heating arrangements, four centrifugal fans are fitted in the roof of the heating chamber to ensure that the highest degree of temperature uniformity is obtained along the full length of the charge.

In order to reduce to a minimum scaling and decarburisation of the tubes, protective atmosphere arrangements are included. The furnaces are of fabricated gastight construction, the casing plates being seam welded, while the fan shafts, element lead-outs, thermo-couple tubes, &c., are suitably glanded. Before a charge is introduced the heating chamber is purged and the air replaced by an exothermic atmosphere produced from a G.W.B. burnt town's gas plant with a capacity of 2000 cubic feet per hour. This atmosphere is passed through an automatic regenerative drier before entering the furnace chamber. After a certain period this atmosphere is replaced by one from an endothermic unit in which the town's gas/air mixture is cracked by externally applied heat in the presence of a catalyst. This endothermic plant has a capacity of 1500 cubic feet per hour, of which 500 cubic feet is fed to other furnaces supplied by Wild-Barfield Electric Furnaces, Ltd.

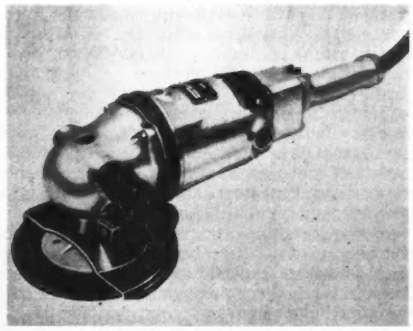
The five furnaces form a part of a large batch furnace installation which is serviced by a turntable, extending-arm, charging machine. The hearth of each furnace is fitted with three grooves to accommodate the charging machine arms while heavy cast plates covering the hearth support the charge, and serve to protect the hearth heating elements. A series of loading and unloading tables are situated alongside and between the furnaces to permit semi-continuous operation of the whole furnace installation.

Two of five furnaces for spheroidising steel tubes used in bearing manufacture

Heavy Duty Portable Electric Sander - Grinder

A NEW portable electric industrial tool, known as the 7in heavy duty, optional speed, sander-grinder, has been introduced by Black and Decker, Ltd., Harmondsworth, Middlesex, to supersede the firm's 7in heavy duty sander. This tool is stated to be 90 per cent more powerful and much lighter than the tool it replaces, and it is available in three models, with spindle speeds of 4200, 5200 and 6000 r.p.m. Each model is designed for a specific range of work, the two lower-speed models being suitable for use with planer heads for wood, saucer grinding wheels, wire cup brushes and sanding discs. The high-speed model is primarily intended for use with Nylon bonded, depressed-centre cutting-off wheels, which require higher speeds and constant power for satisfactory operation.

One of the new tools fitted with a Nylon bonded cutting-off wheel is illustrated below.



7in heavy duty sander-grinder fitted with Nylon bonded depressed centre cutting-off wheel

The tool has a rated input of 1060W and is available in a number of standard voltages. A replaceable steel ring is fitted to protect the main housing from wear and damage, and the brush gear is fully protected against the ingress of dust. A removable steel inspection plate, giving access to the brushes and commutator, also provides a wear-resisting plate to the rear part of the housing. The switch is enclosed in a compartment to protect it from abrasive dust and guards are fitted to prevent accidental operation of the switch. The tool weighs some 14 lb and a large rear handle and a side handle are suitably arranged to give good balance when the tool is being handled. Two wheel guards are supplied, one for use with 7in depressed-centre wheels and the other for 9in wheels. These guards are fixed on the spindle bearing boss by means of a clamp and bolts.

To provide the minimum of rotating weight with the maximum of flexibility for sanding with 7in abrasive discs, the tool is supplied with a 5in diameter moulded rubber backing pad and a 6¾in diameter plastic " Koolflex " backing pad. For 9in discs an 8¾in " Koolflex " pad is available and should a more rigid backing be required for the larger sanding discs, the two pads can be used together.

Industrial and Labour Notes

Iron and Steel Production

Steel production in Great Britain in the month of August averaged 345,100 tons a week, which represented an annual output of 17,946,000 tons. This, the Iron and Steel Board says, was the highest output rate ever achieved in the month of August, a period, of course, which is always affected by annual holidays. In August last year steel production was at an annual rate of 16,932,000 tons. Pig iron production in August averaged 236,200 tons, and was thus at an annual rate of 12,282,000 tons, compared with a rate of 11,823,000 tons in August, 1954.

National Coal Board's Statistics

The National Coal Board's statistical statement for the second quarter of 1955 shows that proceeds of the sale of coal amounted to £163,859,242 and that the total costs of production were £171,733,296, so that there was a loss, before charging interest, of £7,874,054, or of just over 3s on every ton of coal sold. The statement shows, on the credit side, estimated profits on opencast working of £425,000 and on ancillary undertakings of £250,000, which reduce the quarter's trading losses to £7,199,054. But a loss on imported coal amounting to £6,700,000, and provision for interest, amounting in all to £5,290,000, brought the total estimated deficit for the quarter to £19,189,054, a result which was about £13,000,000 worse than that of the first quarter's operations. The saleable quantity of coal from the Board's mines during the second quarter was 51,178,926 tons, of which 47,765,976 tons were commercially disposable.

In some comments on the statement, the National Coal Board has pointed out that the second quarter contained the Easter and Whitsun holidays and the beginning of the annual holiday season. Other factors of importance which must be taken into account included the introduction of a national day-wage structure in April, estimated to cost £14,000,000 a year; the strike in May in the Yorkshire coalfield, with serious effects upon output, and the railway strike in June, with consequential effects in stocking and other special costs. Then, the Board says, there was the "full emergence" of past trends of rising prices, as, for example, in roof supports, general stores and repairs, which have also been affected by the increased use of special roof supports and fireproof belting. Other increases in costs have been brought about by greater capital expenditure, more expenditure upon research and training, increases in National Insurance contributions, contributions to the National Industrial Fuel Efficiency Service and the general rising trend of administrative expenses.

The Board goes on to explain that the results of opencast working in the second quarter were affected by stocking in consequence of the railway strike and by the general tendency for an increase of production costs which were over 3s a ton higher than in the comparable quarter of 1954. The Board's final comments about the statement are about the loss of nearly £7,000,000 on imported coal, and that the adverse financial situation resulted in increased inland selling prices of coal as from July 18th.

Anglo-German Fuel Talks

At the beginning of this week a delegation of British industrialists left for Germany for talks on fuel and power problems with German industrialists. This delegation has been organised by the Association of British Chambers of Commerce and is led by Mr. G. M. Flather, chairman of the Association's fuel and power panel.

It is stated that one of the principal objects of this visit is a general exchange of views on the supply and prices of coal in Western Germany and the United Kingdom. This includes discussions on coal mining productivity, the economics of coal production and the relationship of these matters to the structure and organisation of the coal mining industry in both countries. There have also been conversations on the progress being made in both countries in the efficient and economic use of solid fuels, especially coal, with special reference to the economics of fuel efficiency in relation to other capital demands and the rising price of coal. The Association of British Chambers of Commerce says that it attaches special importance to this point in view of its constant drive for increased efficiency as a means of countering the effect of increasing coal prices.

Management in the Mining Industry

Last week the National Coal Board's ninth annual summer school was in session at Oxford. It was attended by nearly 500 students from all sectors of the industry.

The opening lecture was given by Sir Andrew Bryan, the staff member of the National Coal Board, who dealt with the subject of management in the mining industry. A large part of Sir Andrew's lecture was concerned with the recommendations made by the Fleck committee, which recently examined the Coal Board's organisation. Sir Andrew then went on to say that, whatever economies were effected by better deployment to make the best use of existing technical staff, reinforcement of the management team would still be necessary at many pits. In spite of the Fleck committee's statement, too often the management team was weak on the engineering side, since the volume of available engineering staff had failed to keep pace with the rapid extension of mechanisation; work study engineers were conspicuous by their absence, and there was hardly a single colliery with an official in control of the transport or supplies operations as a whole.

On the more general aspects of the matter, Sir Andrew said that the very essence of good management was the need to collect and use adequate information. Unless there was a system by which the colliery manager and his subordinates were kept continuously and clearly informed about what was happening throughout the colliery, good management became impossible. Investigations at a number of collieries, Sir Andrew stated, showed wide divergences in their systems of communication, for no apparent reason. There were big differences in the standard of reporting, in the number of reports called for, in their timing and in their subsequent processing, and study of them after collection. There was, he added, a great lack of uniformity about the kind of information that managers regarded as essential for the task of controlling and co-ordinating operations at their pits.

Trade Unions and Automatic Manufacturing

Amongst the various topics debated at the recent Trades Union Congress at Southport was a debate on automation. The spokesman for the general council was Mr. James Crawford, chairman of the T.U.C.'s production and scientific advisory committees and president of the Boot and Shoe Operatives. It was of the utmost importance to any union to determine, he said, with their opposite numbers among the employers how they would cushion and protect their members against the advance of new ideas such as automation: if it were redundancy, for example, to try to make some sort of arrangement that would be helpful. But from the point of view of the T.U.C. where the interests of all unions had to be considered, it really did not matter whether diminution took place in the ranks of the union, provided that those workers were not left high and dry, but would find their place in other industries. Automation might be coming quickly—personally, he did not think so—but it was only a sort of quickening of the process that had been going on since ever industrial life had been started. For the year 1937, for example, Mr. Crawford noted, if he said there were 100 people employed in textile industries, then there were only seventy-two to-day. If he took the electrical industry, for every 100 employed in 1937 there were 165 people to-day; and for the chemical industry, for every 100 employed in 1937, there were 198 people to-day. All that shifting was going on between industries all the time and so long as there was full employment it could be absorbed without any suffering. Indeed, it was for the betterment of most of those people. The great difficulty that might arise with automation, Mr. Crawford went on, would be if it came too speedily. The social side of our life might not be geared to fit it. It was part of the unions' job, he concluded, to make absolutely certain that both the Government and the unions met their share of that problem. That would help to increase the standards of life in this country by welcoming new ideas and harnessing them to the common good.

T.U.C. Officers and Membership

At the conclusion of the Trades Union Congress at Southport, a new chairman of the general council was elected. He is Mr. W. B. Beard, general secretary of the United Patternmakers Association. He has been a member of the T.U.C. general council since 1947, and has had considerable experience on T.U.C. and governmental committees of various kinds. Two new members of the general council were also elected, namely, Mr. A. Hallworth, general secretary elect of the Associated Society of Locomotive Engineers and Firemen, and Mr. A. L. Hill, of the Transport and General Workers Union.

Figures for membership of the T.U.C. given at the Southport congress showed that membership had again risen. The latest membership figure for the one hundred and eighty-three affiliated unions is 8,106,958, which is correct for the beginning of this year. The increase over last year is 13,121, and the increase over the 1951 membership is 279,073.

"Revolving Fund" for Industry

An explanatory leaflet has been issued by the Board of Trade on the "conditional and revolving" fund for industry setting out the details of the scheme under which manufacturers can apply for short-term loans for the purpose of increasing productive efficiency. This fund was established as part of the conditional aid programme, and under it £700,000 has been allocated to the industrial section. The leaflet points out that repayments should maintain the fund at a level which should avoid any interruption in the issue of new loans, and applications can be made at any time until further notice. In order to spread the benefit of the fund as widely as possible, it is stated that applications should normally be limited to £30,000. As from September 17, 1955, loans will bear interest at 5 per cent per annum. Amongst the conditions laid down for a loan it is required that reasonable security is available; progress reports are made during the period of a loan; knowledge and experience gained as a result of the loan are to be made available to other industrialists likely to benefit, and benefits of higher productivity resulting from the loan are shared with employees and customers. In making loans preference will be given to applications from small and medium-sized firms relating to projects which will yield a substantial and quick return on improved efficiency. An increase in turnover will not be sufficient to justify a loan fully and in order to be eligible the proposed project must lead to greater efficiency in production. Applications for full information on the scheme should be made to Industries and Manufacturers Department (Revolving Fund for Industry), Board of Trade, Horse Guards Avenue, London, S.W.1.

Design Centre for British Industries

The Council of Industrial Design announced at a recent press conference that it was proposed to open a design centre for British industries next spring at 28, Haymarket, London, S.W.1. This centre will provide a permanent, selective, exhibition of the best designs from each trade and will be open all the year round. All the goods displayed will be selected from those submitted to "Design Review," and before being exhibited they will be examined and approved by a committee of the Council. It is emphasised that the centre will be complementary to and not in competition with existing trade exhibitions.

Mobile 5500kW Gas-Turbine-Electric Power Plant

BY OUR AMERICAN EDITOR

The Clark Brothers Company, of Olean, New York, has developed a mobile 5500kW gas-turbine-electric power plant of interesting design for the Bureau of Yards and Docks of the U.S. Navy. The complete installation is mounted within a single railway wagon and can be placed in operation after very little preparation. The plant has as its source of power a newly designed combustion gas turbine which is directly connected to a generator rotating at 3600 r.p.m.

THE 5500kW mobile power generating unit which has been developed and built for the Bureau of Yards and Docks of the U.S. Navy by the Clark Brothers Company, of Olean, New York, is designed specifically as a compact, mobile source of a large amount of electrical power which can be used if an emergency should occur. Even though it is an emergency unit, the power plant is of heavy-duty design and can be operated continuously no matter what the duration of the emergency may be. In the United States, the Bureau of Yards and Docks is responsible for the technical control of the shore stations of the U.S. Navy. Technical control covers a considerable amount of ground but basically means that the Bureau is responsible to see that proper equipment in the correct amount is operated in the proper way at the shore stations. In this capacity, the Bureau was aware that on occasions additional electric power was needed at various shore stations to meet emergency needs. Duplicate stand-by services were entirely too costly to maintain ; therefore, a mobile stand-by unit of substantial power output was considered to be the most economical solution. As a result, the Bureau established the general design requirements for a gas-turbine-driven power plant mounted on a railway wagon. The specifications involved in the design required that the entire unit had to be contained in one railway wagon of such size and design that it could be moved at high speed in any freight or passenger train service without equipment damage. Furthermore, it had to be ready to operate within twenty-four hours after its arrival at a site. Operation on a wide range of liquid and gaseous fuels, in combination or interchangeably, was another important consideration. The only connections necessary were to be to a fuel source and to the transmission line ; water supply was not be be required. The gas-turbine-driven unit developed by the firm is designed to meet all of these specifications.

The first one of these " Turbo-Mobile " power units has now been built by the company under contract to the U.S. Navy. A second unit, rated at 6200kW, is being manufactured for the Comision Federal de Electricidad in Mexico, and will be placed in operation next spring. A very important use for such mobile power plants is to meet emergencies which frequently arise from natural causes such as floods, fires, tornadoes, hurricanes and earthquakes. Mobile power plants, strategically located throughout such areas, could quickly make power available wherever it is needed. In the event of hostilities, these power plants would also be well suited to be moved in on ships to base areas.

The power plant is a self-contained 5500kW unit rated at 80 deg. Fah. ambient temperature up to an altitude of 1000ft. The prime mover is a simple, open cycle, dual shaft, series flow gas turbine directly connected to a two-pole synchronous generator. The complete plant with auxiliaries, controls, fuel storage and handling facilities, auxiliary engine-driven generator and station switchgear is mounted on one wagon suited to freight or passenger train use on American standard gauge track (Fig. 1).

Performance Characteristics

The gas turbine (Fig. 4) consists of an axial-flow compressor and an axial-flow turbine with two shafts. The first (high-pressure) turbine, consisting of two stages, drives the axial-flow compressor supplying combustion air. The second turbine, running independently, drives the load generator directly at 3600 r.p.m. The following is the performance of the machine at various load conditions :—

Loading	Output, kW	Heat rate, B.Th.U. per kWh	Thermal efficiency, per cent
Full load ...	5,500	18,000	19
Three-quarter load	4,125	20,600	16·6
Half load ...	2,750	34,200	13·2

Facilities are provided in the fuel system for operation of the gas turbine with residual fuel oils. In order to minimise the effects of vanadium attack, blade fouling from ash deposit and other faults arising from the combustion of this kind of fuel, it will be necessary to limit the turbine inlet temperature to 1150 deg. Fah. The expected maximum station output when operating at this limiting turbine temperature is 3200kW.

Turbine Design

Combustion air is supplied by a thirteen-stage axial-flow compressor at a pressure ratio of 4·25 and a flow of 100 lb per second. The compressor is driven through a flexible coupling by the high pressure turbine at 5000 r.p.m. The compressor case is split on the horizontal centreline, thus providing ease of assembly and accessibility (Fig. 2). The rotor is a two-piece forged drum with circumferential " T "-grooves. The blading is designed with low loading factors, resulting in long life and high efficiency. The rotor blades are inserted through a single slot which is closed by means of a locking insert. The stator blades are mounted in quarter-circular rings, which are easily accessible and may be rolled out of the casing for inspection purposes. The rotor need not be removed during stator blade inspection. The compressor rotor is dynamically balanced to ensure smooth running under all operating conditions.

Fig. 3—Single contra-flow combustion chamber with three burners

The combustion of the fuel is accomplished in a single, contra-flow combustion chamber (Fig. 3). The single combustion chamber used gives the simplest possible arrangement without the matching difficulties of multiple chambers. It consists of two shells (Fig. 4) forming an inner combustion area and an outer annulus. Primary air flows through the outer annulus to the end of the chamber and enters the inner area where fuel is injected and burned. The secondary air passes from the outer annulus through openings into the inner chamber, where it mixes with the products of combustion. The air flowing through the outer annulus also cools the inner walls to a temperature consistent with long life. Combustion chamber liner changes are not required during the life of the turbine. The unit

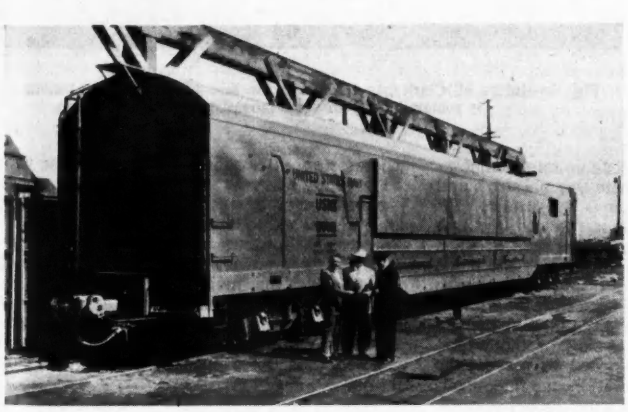


Fig. 1—American standard gauge railway wagon containing 5500kW mobile power plant

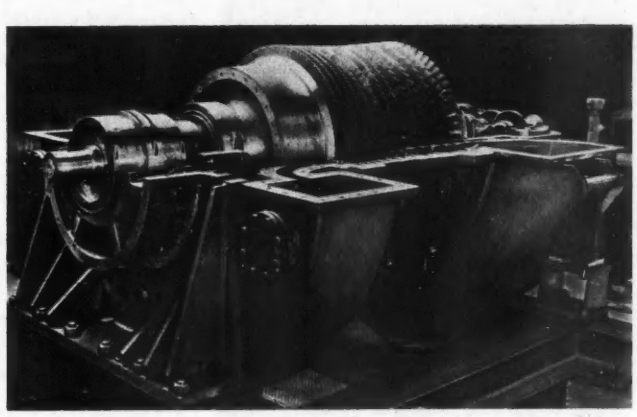


Fig. 2—Thirteen-stage axial-flow compressor with upper casing removed

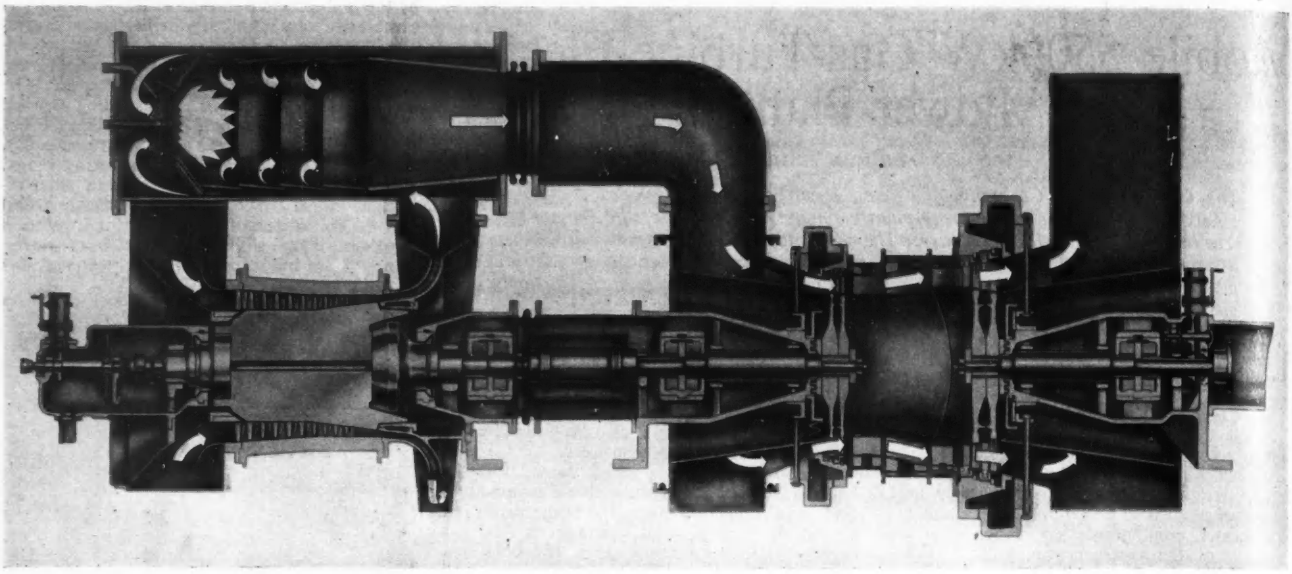


Fig. 4—Diagrammatic cross-section of open-cycle, dual-shaft gas turbine plant

is equipped with three fuel atomisers. To facilitate maintenance the nozzle installations are designed so that any one area may be shut off and removed for cleaning or replacement while the turbine is in operation. The turbine is designed for normal operation at an inlet temperature of 1350 deg. Fah. Temperatures in excess of 1350 deg. Fah. may be maintained for varying percentages of operating time, as listed below :

Turbine inlet temperature	Percentage of operating time
1350 deg. Fah.	100 per cent
1370 deg. Fah.	100 per cent
1400 deg. Fah.	25 per cent
1425 deg. Fah.	5 per cent
1450 deg. Fah.	1 per cent

The turbine consists of two separate units—the high-pressure turbine, which is a two-stage unit operating at 5000 r.p.m. driving the axial compressor, and the low-pressure turbine, which is a two-stage unit operating at 3600 r.p.m. driving the load generator. The rotor blades (Fig. 5) are forged and shrouded to reduce inter-stage losses. The stator blades are precision castings and are attached to carrier rings with controlled clearances permitting thermal expansion without strain or distortion. Tip and turbine disc labyrinth seals are provided to minimise leakage. The separate turbine design allows the mounting of the two sub-assemblies on two separate bases. A flexible duct connecting the high-pressure turbine is easily removed. This area then provides access to both turbines, either of which may be completely inspected by the removal of individual wheels and nozzle rings.

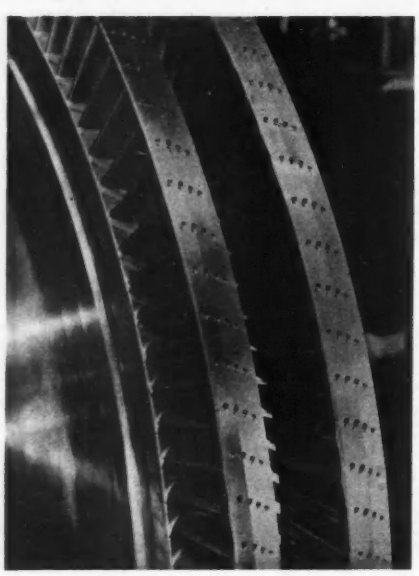


Fig. 5—Shrouded blades of two-stage high-pressure turbine

All radial bearings of the machine are babbitted bronze-backed precision bearings, while the thrust bearings are the conventional Kingsbury units. The power plant is mounted within the wagon on two independent sub-bases. One supports the compressor and first turbine, the other one supports the second turbine and the generator-exciter combination. Each sub-base is supported at three points selected to ensure minimum deflections. This three-point suspension is designed to provide the correct degree of freedom at each joint and will thus permit normal deflection of the basic carriage structure without causing any shaft misalignment. Relative movement due to such deflections between the respective sub-bases will be readily accommodated by the flexible duct installed between turbines. The thermo-elastic support system employed in carrying the turbines holds the hot parts inside a cold ring. The hot components may expand and contract concentrically without influencing the alignment.

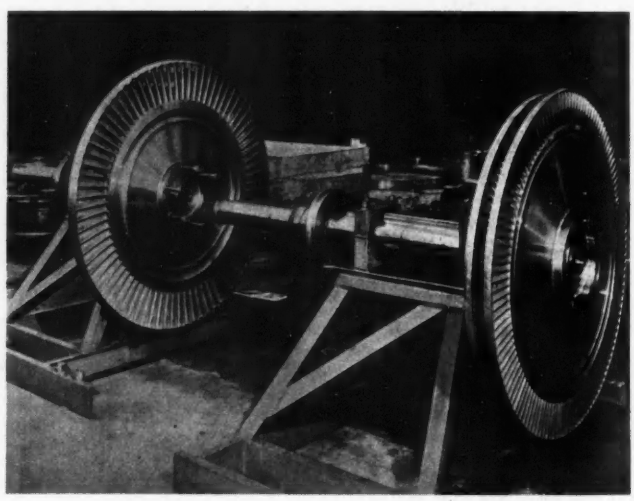


Fig. 6—Rotors of Clark gas turbine. One disc of low-pressure turbine is removed (left) to show mounting details

The air cooling system was designed to ensure rapid trouble-free starting and stopping. Cooling maintains all supports at a minimum temperature, thus tending to eliminate thermal stress and alignment problems. Water is not required for cooling purposes. Air is introduced through openings on the inner diameter of the first-stage stator ring. The cool flow of air over the blade roots and the supporting disc gives a low mean temperature which is consistent with long life.

Only minor preparation is required at the site before starting up. The brakes of the wagon are set and the wheels blocked to prevent the wagon from rolling. In addition, the filter sheds are opened, the turbine exhaust duct is opened, and the fuel and electrical connections are made. The power plant is now ready for starting up. Only one trained operator is required to start and operate the plant. Initially, the auxiliary diesel engine which is used to bring the turbine up to sustaining speed is started. This unit also provides all of the power required for the electric auxiliaries. When all requirements for starting are met, a ready-to-start lamp comes on indicating that the operator can press the start button. This initiates a series of automatic operations—ignition on, igniter air on, and igniter fuel on. The pilot flame, sensed by the combustion control pilot scanner, opens the main fuel valve. When sustaining speed is reached on the turbine, the starting engine automatically disengages. After turbine warm-up, the main generator speed is adjusted to synchronise with the auxiliary generator which is then shut down. The main circuit breaker is closed and the turbine control switched to automatic.

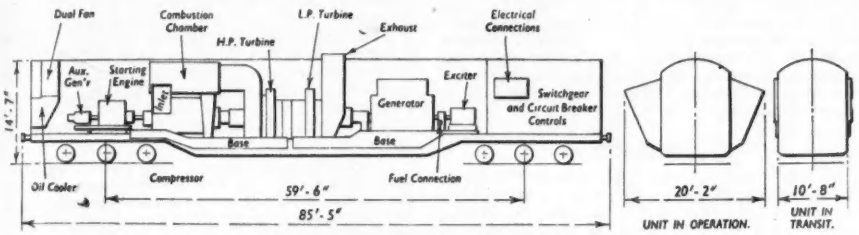
A normal shutdown is accomplished by reducing the turbine power setting gradually to idling and opening the main circuit breaker. The auxiliary diesel is restarted and the electrical load of the auxiliaries is taken over by the diesel-engine-driven auxiliary generator. The main unit can then be stopped by pushing the stop button.

Electrical Equipment

The synchronous generator is rated 5500kW, 3600/3000 r.p.m., 60/50 c/s, 12·5kV, 80 per

cent power factor, three-phase, 40 deg. Cent. ambient temperature, is of two-pedestal bearing construction, and is driven directly from the gas turbine output shaft through a flexible coupling. The oil-lubricated sleeve bearings are fitted with oil flow indicators, bearing temperature relays and lubrication fittings. Temperature detectors are embedded between the stator coils and connected to a panel-mounted temperature indicator. The generator is totally enclosed and is of self-ventilated design. Two aerodynamic blowers, one at each end of the rotor body, force air through the frame-ventilating system.

Mounted on top of the generator frame is a large terminal box which houses the following :— (1) Three current transformers arranged to provide differential protection of the stator



Track weight, 410,000 lb. Minimum turning radius, 250ft.

Fig. 7—Diagram showing general arrangement of mobile power plant

windings ; (2) a neutral reactor furnished to limit ground fault current and a fourth current transformer to energise a ground detection relay ; (3) a knife switch to disconnect the ground circuit ; (4) two 15kV, 400A, potheads for the generator leads. A rotor locking device is built into the generator to prevent any movement of the generator rotor in its bearings during transit. The direct-connected exciter is driven through a flexible coupling from the extension of the main generator shaft. The two sleeve bearings of the exciter are lubricated from the common oil lubrication system. A small tachometer generator is direct-connected to the shaft extension of the exciter ; its output is connected to a panel-mounted voltmeter which reads in revolutions per minute. The generator switchgear and control apparatus (Fig. 8) is enclosed in a metal cabinet and consists of the main power circuit breaker, various smaller breakers, busbars, potential and current instrument transformers and various smaller items of instrumentation and relaying. All metering and protective devices are centrally grouped so that all of them can be observed from one location. Dual metering and suitable transfer switches are installed and used to make the apparatus suitable for operation at frequencies of either 50 c/s or 60 c/s. Synchronising lamps are supplied to facilitate paralleling.

All of the electrical apparatus is suitably treated to make it fungi-proof. None of the switchgear or control apparatus need be dismantled and stowed while the power plant is in transit. Such design and construction facilitates putting the mobile power plant in service promptly upon arrival at any site. The automatic voltage regulators, exciter field rheostats and generator field discharge resistors are factory installed and wired in the switchgear. The main power circuit breaker is a stationary oil circuit breaker with an interrupting capacity rating of 500,000kVA.

An auxiliary generator is provided which is driven by a 159 b.h.p., two-stroke, 1800 r.p.m., six-cylinder diesel engine. The same engine, driving from the opposite end of the shaft through a hydraulic torque convertor, serves as the starting engine for the main unit. The auxiliary generator is rated at 50kVA at 80 per cent power factor, 480V, three phase, 60 c/s. It may also be operated at 50 c/s by reducing the speed to 1500 r.p.m. where voltage is reduced to 400V. This generator supplies all electrical power necessary for starting up, shutting down, and cooling operations. In addition, it supplies all station lighting and power requirements when the main generator is not producing power.

The lubricating system is a common system for all equipment. Oil for the bearings and the starting speed increaser gear is contained in a main 500-gallon tank. Three pumps are included: the main pump which is driven from a gear on the compressor shaft, the auxiliary a.c. electrically driven pump for automatic supply when the main pump is not delivering sufficient pressure, and the auxiliary d.c. electrically driven pump which operates on total electric power failure. Each pump is protected against back flow from any other pump by a check valve. The a.c. pump pressure is regulated to a valve below the main pump to avoid hunting from the automatic starting equipment operating on low bid pressure. This pump also starts automatically with any operation which would cause rotation of any shaft of the engine or the generator. Since the d.c. pump starts on a.c. power failure and not in low pressure, it does not require a separate by-pass line and regulator. Full filtering is accomplished with duplex filters which may be cleaned while in operation. Micro-filtration is through a 10 micron filter with bleed arrangement. Return flow of oil from all bearings is through gravity scavenge lines back to the main tank.

The fuel system is designed for operation with No. 2 diesel fuel oil. Provisions are made to burn residual fuels after making minor adjustments to the pressure regulators and the valving. The main fuel day tank has a capacity of 500 gallons. Fuel is pumped from the heated tank through strainers to the fuel nozzles in the combustion chamber where it is atomised and burned Fuel flow is regulated by a pneumatically operated valve. The valve is operated in accordance with the load demands of the governor. The upstream fuel pressure is controlled by a diaphragm regulator which returns excess fuel to the tank. The auxiliary diesel fuel system is supplied by a separate 500-gallon tank for starting and shutting down whenever residual fuel is to be used in the main system. It is piped and valved so that after shutting down the complete system may be purged with diesel fuel to prevent congealing of the residual fuel as it cools.

The governor control system is a pneumatic system which regulates the alternator speed or frequency by regulation of the fuel flow rate. The primary control is the speed governing system. The speed transmitter transmits a signal to the speed recording controller which in turn transmits a control signal to the valve positioners through the pilot valve, the low pressure selectors and the automatic-to-manual switching unit. The ranges of the valve positioners are such that the low capacity valve is completely opened before the high capacity valve opens. The acceleration of the axial compressor is regulated by means of a secondary over-riding control during starting. This secondary control limits the turbine acceleration by limiting the turbine temperature. The temperature transmitter transmits a signal to the temperature recording controller. The temperature recording controller transmits a control signal to the valve positioners over-riding the primary speed control at the low pressure selectors. The temperature set point on the temperature recording controller is reset automatically in a cascade manner by the pressure controller. The pressure controller resets the temperature by receiving a pressure signal which is a function of the compresssor speed from the pressure transmitter and raises the temperature set point sufficiently to prevent over-rapid acceleration. The turbine temperature while operating under overload condition is limited by a temperature limiting control. The temperature limiter may be set at any desired maximum temperature which will over-ride the signal sent to the temperature recording controller by the pressure controller. The pilot valve automatically substitutes a manually preset signal corresponding to an idling speed for the signal from the automatic control systems to the valve positioners in the event of speed transmitter failure. A pressure alarm also transmits a signal to the annunciator giving warning of such an event. The flow transmitter transmits a signal to a flow recorder. The control of the turbine may be switched from automatic to manual control with the "automatic-to-manual" unit.

The railway wagon (Fig. 1) is built with two major Pratt side trusses. Each truss is made with an extra-heavy lower chord member to carry longitudinal coupler forces as well as concentrated loads from the sub-base connections. Cross bracing is installed at the lower chords in the form of bulkheads between the turbine components and provides fuel and lubricating oil tankage. Upper chord cross bracing is provided as an integral part of the roof trusses and is made removable to facilitate maintenance work. The wagon is mounted on two 3-axle bogies designed in accordance with the specifications of the American Association of Railroads and for the maximum centre plate loading imposed by the wagon and all equipment. Since no centre sill may be installed because of the size of the unit, the coupler forces will be transmitted through horizontal shear members to the lower chord members of the side trusses.

Fig. 8—Control room with electrical switchgear and control apparatus

Filter area for compressor air and generator cooling, and catwalks for access to the various components are contained in extendable wagon sides. When in transit, these sides fold up to enclose the carriage and in that condition are within the profile limits. The main lubricating oil coolers and the auxiliary engine cooler are situated in the end of the wagon. The main fan and the emergency fan are situated in opposite sides of the wagon and discharge into a common plenum chamber, thence through the radiators to the outside. The roof is made in four main sections and one exhaust section which are bolted to the top chords of the side trusses. During operation the section over the turbine exhaust is opened. For normal maintenance, the roof sections need only be opened up over the particular area in work. For major overhaul work, external crane facilities are generally available to facilitate roof sections being completely removed. All switchgear and controls are housed in the control room in the generator end of the wagon which is acoustically and thermally insulated from the turbine compartment.

Personal and Business

Appointments

MR. F. A. POPE has been appointed an additional director of the John Bull Rubber Company, Ltd.

MR. L. G. EARLE has been appointed a director of Campbell, Gifford and Morton, Ltd., 161, Queens Road, Weybridge, Surrey.

MR. S. H. PARKER has been appointed general manager of Teddington Industrial Equipment, Ltd., Sunbury-on-Thames, Middlesex.

MR. G. GIDEON HOUSTON has been appointed to the North of England sales staff of Marsh Brothers and Co., Ltd., Ponds Steel Works, Sheffield.

MR. T. E. WILSON, A.M.I.E.E., has been appointed assistant (electric traction and generation) to the Chief Mechanical and Electrical Engineer, British Railways (London Midland Region), Derby.

MR. FRED KENDRICK has been appointed a director of the Sheffield Forge and Rolling Mills Company, Ltd., Millsands, Sheffield. Mr. Kendrick has, until recently, been the works manager and has completed fifty-three years in the company's service.

BARLOW-WHITNEY, Ltd., announces the appointment of Mr. J. T. Sharples as manager of its main plant at Bletchley, Bucks. Mr. Sharples has been manager of the company's northern area branch at 32, Deansgate, Manchester, and has been succeeded in that appointment by Mr. G. H. Toller.

BIRMID INDUSTRIES, Ltd., announces three new appointments to the board: namely, Mr. J. W. Berry, joint managing director, Birmingham Aluminium Casting (1903) Company, Ltd.; Mr. H. Goodwin, joint managing director, Birmetals, Ltd., and Mr. G. A. Rider, commercial director, Birmingham Aluminium Casting (1903) Company, Ltd.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., has appointed Mr. A. Walsh, Assoc. M.C.T., M.I.E.E., as consulting engineer (patents), following the retirement of Mr. L. H. A. Carr; Mr. S. Andrew has been appointed as assistant superintendent, transformer department, and Mr. K. M. Miller, A.M.I.E.E., assistant superintendent, "G" aisle department.

MR. S. W. T. MITCHELMORE, United Kingdom Trade Commissioner at Vancouver, leaves Canada on October 28th at the end of his tour. He will be succeeded in Vancouver by Mr. P. B. Hunt, formerly a United Kingdom Trade Commissioner at Montreal. Mr. D. M. J. Gwinnell, at present serving in Engineering Industries Division of the Board of Trade, is being appointed Trade Commissioner at Montreal in succession to Mr. Hunt.

Business Announcements

MR. J. J. H. ATHERTON has retired from his agency for Ferodo, Ltd., which he has maintained for forty-six years.

DORMAN SPRAYER COMPANY, Ltd., states that its works and head offices are now established at Ditton Walk, Cambridge (telephone, Teversham 379).

THE BOARD OF TRADE states that the address of the United Kingdom Trade Commissioner in Toronto is now 119, Adelaide Street West, Toronto, Canada.

MONSANTO CHEMICALS, Ltd., states that it has authorised expenditure of more than £500,000 for the construction of a new plant at its Newport, Mon, factory for the manufacture of phthalic anhydride.

TUBE INVESTMENTS, Ltd., announces the formation of a new company, Tube Products of India, Ltd., for the manufacture of electric resistance welded steel tubes. A building site of 80 acres has been acquired near Madras.

P.I. CASTINGS (ALTRINCHAM), Ltd., has opened a London office at 69, New Cavendish Street, W.1 (telephone, Langham 7511). Mr. P. G. Chapman has been appointed technical representative for the southern counties.

CHAMBERLAIN INDUSTRIES, Ltd., Staffa Works, Leyton, E.10, has appointed Drummond-Asquith (Sales), Ltd., King Edward House, New Street, Birmingham, 2, as sole distributor in this country and overseas of its hydraulic draw bending machines.

PERMALI, Ltd., Gloucester, states that, following the merger last year with Hordern-Richmond, Ltd., new Manchester premises for both companies have been opened at Third Floor, B Block, 89, Oxford Street, Manchester, 1. This address is also the Northern office of the newly formed company, Hydulignum-Jabroc (Tools), Ltd.

LIEUT.-GENERAL SIR RONALD WEEKS, K.C.B., C.B.E., D.S.O., M.C., T.D. (chairman of Vickers, Ltd.), relinquishes the office of chairman of English Steel Corporation, Ltd., with effect from October 1, 1955. Mr. F. Pickworth will relinquish his present office of managing director of English Steel Corporation, Ltd., and will take over the office of chairman of that company. He will also join the board of Vickers, Ltd., on October 1, 1955. Mr. W. D. Pugh will, on the same date, be appointed managing director in place of Mr. Pickworth.

THE UNITED STEEL COMPANIES, Ltd., will move its Manchester office on September 24th to larger premises at National Building, St. Mary's Parsonage, Manchester, 3. The telephone number remains unchanged—Blackfriars 3526. Mr. H. A. Wilkinson is manager of the Manchester office, which is responsible for the company's sales in Lancashire, Cheshire, North Wales and part of Staffordshire.

GEO. SALTER AND CO., Ltd., West Bromwich, announces changes in the sales organisation of the firm's balance division. Mr. J. H. Walter has been appointed general sales manager, responsible for home and export sections; Mr. C. P. Turnbull, formerly with Thos. French and Sons, Ltd., has been appointed export sales manager, and Mr. T. Kennedy has joined the company from J. Goddard and Sons, Ltd., as home sales manager.

Contracts

FRASER AND CHALMERS ENGINEERING WORKS OF THE GENERAL ELECTRIC COMPANY, Ltd., has received a contract from Ilva Altifoni e Acciaierie d'Italia, Genoa, for a Robins-Messiter ore blending plant to be installed at its Piombino steel works.

THE BUTTERLEY COMPANY, Ltd., has secured a further contract for an oxygen-nitrogen plant to be installed at the Billingham Division of Imperial Chemical Industries, Ltd. This plant will produce 240 tons of high purity oxygen per day and will also produce 400 tons of very high purity nitrogen per day.

THE BRITISH TRANSPORT COMMISSION states that a contract for five 150 h.p. power cars and five trailer cars for multiple-unit diesel trains has been placed with D. Wickham and Co., Ltd., Ware, Hertfordshire, as part of the British Railways modernisation plan. The power units will be provided by the British United Traction Company, Ltd. These cars will be used in the Eastern Region.

RICHARD SUTCLIFFE, Ltd., Horbury, Wakefield, has received an order from Colvilles, Ltd., through Ashmore, Benson, Pease and Co., Ltd., for the supply and erection of a materials handling scheme for the Ravenscraig project at Motherwell. The equipment includes fourteen belt conveyors together with screens, feeders, bunkers and structural steelwork for the handling of home and foreign ore, limestone, coke, breeze and flue dust.

W. G. BAGNALL, Ltd., Stafford, has received a contract from the New Zealand Government Railways for the supply of seven 0-4-0 diesel-mechanical shunting locomotives. Two of the locomotives will be powered with Gardner "6L3" engines and the remainder with McLaren "M6" engines. The nominal horsepower will be 150 and the weight in working order, 20 tons. The transmission will consist of a "Fluidrive" hydraulic coupling and four-speed gearbox, and a reverse and final drive box which will be supplied by the Self Changing Gear Company, Ltd.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby, has received an order valued at £750,000 from the New Zealand Government (on behalf of the New Zealand Ministry of Works (for five steam turbo-alternator sets for installation at the No. 1 Wairakei Geo-Thermal Power station. It is here, in the north island of New Zealand, that a vast project is being developed to produce heavy water, which is used as a moderator in nuclear reactors. Two of the sets will be of the back-pressure type, driven by steam from thermal bore holes at 180 lb per square inch gauge and 380 deg. Fah., the steam being exhausted at 50 lb per square inch gauge into the heavy water plant. The remaining three sets will use the same steam after it has passed through the heavy water plant; these sets are being designed for steam conditions of 15 lb per square inch absolute and 213 deg. Fah., and will exhaust into jet condensing plants supplied by The Mirrlees Watson Company, Ltd., The consulting engineers are Messrs. Merz and McLellan.

THE ENGLISH ELECTRIC COMPANY, Ltd., has received a contract, valued at approximately 25,000,000 Hong Kong dollars, from the Hong Kong Electric Company, Ltd., for the construction of a power station which will be known as North Point "B" and which will be sited next to the existing power station. The ultimate generating capacity will be 180MW. The English Electric Company, Ltd., states that the engineering and co-ordinating of the whole contract will be carried out by its general engineering projects department, London. The company will supply, erect and set into operation a 30MW, 600 lb per square inch, 850 deg. Fah., 3000 r.p.m. steam turbo-alternator set as well as the switchgear, the transformers and all the other electrical and auxiliary equipment. Generation will be at 11·8kV, stepped up through a 37,500kVA transformer feeding into the Hong Kong Electric Company's distribution network at 22kV. The main sub-contractors are George Wimpey and Co., Ltd., Babcock and Wilcox, Ltd., and British Insulated Callender's Cables, Ltd.

Miscellanea

FIRE-FIGHTING HOSE.—A hose now marketed by the British Tyre and Rubber Company, Ltd., Herga House, Vincent Square, S.W.1, does not, like a canvas hose, become saturated with water, and, therefore, does not need to be dried after use. The "Plastidry" hose consists of a tough plastic tube with a fabric reinforcement embedded within it, and the smooth inner surface allows up to 60 per cent more water to be delivered than from a canvas hose. End fittings can be wired on in the normal way. The hose is also stated to be impervious to acids, oils and alkalis, and can be used to handle drinking water. It resists charring and burning.

EXHIBITION OF JIG BORING.—The Newall Engineering Company, Ltd., of Peterborough, announces an exhibition, to be held at the Birmingham Exchange and Engineering Centre from October 4th to 14th, inclusive, at which there will be shown the firm's new model "2436" jig boring machine, together with a full range of auxiliary equipment. During the exhibition, which will be open daily from 10 a.m. to 1 p.m., and 2.30 p.m. to 7 p.m., a film will be presented showing points of interest in connection with manufacture of the machine. Production boring technique as applied to accurate, economical machining of batch components, will be demonstrated continuously throughout the period of the exhibition.

ATOMIC WEAPON TESTS.—The Ministry of Supply has announced that, with the co-operation of the Australian Government, a third series of atomic weapon tests is to be conducted on the Monte Bello Islands in April next year. There will be no danger to people or stock on the mainland and detonation will only take place when the meteorological conditions are fully satisfactory. The scientific director of the tests will be Mr. C. A. Adams, who was deputy scientific superintendent at the first Monte Bello tests in 1952, and was scientific superintendent for the second series staged at Emu under Sir William Penney in 1953. A fourth series of tests is to take place later next year, under the direction of Sir William Penney, at Maralinga, in the Central Australian desert, where an atomic weapons proving ground is being constructed.

MR. HOWARD EVANS.—We regret to have to record the sudden death on September 11th, of Mr. Howard Evans, superintendent of the Mond Nickel Company's research laboratory at Birmingham. Mr. Evans was born in 1907 and, after studying metallurgy at Sheffield University, where he graduated A.Met. with the award of the Mappin Medal and Premium in 1930, he was employed in the research department of the Metropolitan-Vickers Electrical Company, Ltd., Manchester. In 1938 he joined the development and research department of the Mond Nickel Company, Ltd., as research metallurgist in the Birmingham labroratory. In 1945 he was appointed principal assistant to the superintendent, and in May, 1954, superintendent of the laboratory. Mr. Evans was elected a Fellow of the Institution of Metallurgists in 1946, and was a member of the Iron and Steel Institute, the Institute of Metals, and other societies, to which he has presented numerous technical papers on many metallurgical subjects. Last year he was president of the Birmingham Metallurgical Society.

BRITISH TECHNICAL AID FOR AMERICAN WHEEL FORGING COMPANY.—It has been announced by Mr. R. G. H. Taylor, the managing director of Taylor Bros. and Co., Ltd., Trafford Park Steel Works, Manchester, that an agreement has been completed whereby the company will render technical aid to the American Rolling Mills Corporation in the installation of a new railway wheel manufacturing plant. This new plant will be based on the principles and design of the Taylor Bros. and Co., Ltd., plant described in our issue of December 5, 1952. There is also to be an exchange of engineers between the two companies to ensure that the methods developed at the Trafford Park Steel Works will be incorporated in the new American plant. In his speech, after the opening of the new wheel plant in Trafford Park, Mr. Taylor said: "If the Americans were to come to England and see the plant which you have seen to-day, we might have the Anglo-American Productivity Council working in reverse." In making his announcement of the technical aid to be given, Mr. Taylor said that it was a source of great satisfaction that this prophecy has come true.

British Patent Specifications

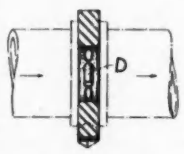
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. each.

INTERNAL COMBUSTION ENGINES

734,816. June 18, 1953.—ATOMISERS, James Albert Wain, 28, Asser Road, Liverpool, 11.

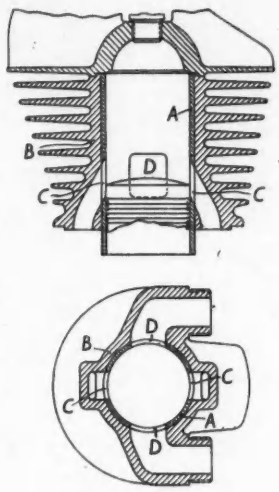
The invention concerns an improved atomiser for internal combustion engines, and it relates to a device for location between the carburettor and the induction manifold which will provide an economy in fuel consumption and improve its overall efficiency. As shown in the drawing, the device comprises a metal block *A*, preferably of a light alloy, of similar shape to the carburettor and manifold flanges. It has an opening *B*, the diameter of which corresponds to the bore of the induction pipe of the engine. A number of bores *C* in the block extend from the opening *B*. Four bores are shown in the drawing, and in each of these bores a tube *D* is partly accommodated. The tubes are solid at their outer ends, where they are fastened into the block by threaded portions *E*. The diameter of each bore *C* is greater than the external diameter of each tube *D*, so that an annular space *F* exists between the two members. The tubes are hollow, apart from their end portions, and each are provided with one or more ports *G* in their walls adjacent the solid end portions. In the arrangement shown, the tubes *D* are provided with hexagonal heads to facilitate removal for the purpose of cleaning or renewing. In the lower view the device is shown fitted between the flanges of the outlet of the engine carburettor and the inlet of the induction manifold. The direction of flow of the fuel-air mixture stream is as shown by the arrows. The mixture leaving the carburettor is stratified with the heavier, incompletely atomised particles of liquid fuel surrounding the drier, completely atomised mixture. The stream rushing past the open ends of tubes *D* causes partial vacuums in them, with the result that particles of fuel in the outer peripheral regions of the stream, the incompletely atomised ones, are sucked up the annular spaces *F*, through the ports *G* and injected out of tubes *D* into the main stream, in a central part and in such a direction as to increase turbulence within the stream. The path of these particles is shown in dotted lines. Furthermore, the heat from the engine is transmitted to the block *A* of the device through the induction manifold and as the particles are travelling up the annular space *F* and down the tube *D*, they are consequently heated. This results in vaporisation which, in turn, assists the atomisation. The tubes may have plain open ends as illustrated, or may be formed into nozzles. Slots *H*, or other similar arrangements, are formed in the block *A* to facilitate its insertion and fixing between the flanges.—*August* 10, 1955.



No. 734,816

735,067. November 3, 1952.—LIGHT METAL CYLINDER FOR AIR-COOLED ENGINES WITH A GREY CAST IRON LINER PRESSED IN, Alfred Kreidler, 1, Gaensheidestrasse, (14a) Stuttgart-O, Germany.

The invention concerns light metal cylinders for air-cooled two-stroke internal combustion engines into which a grey cast iron liner is pressed. As will be seen from the drawing, a liner *A* of grey cast iron is pressed into the bore of a light metal cylinder *B*, which, as usual, is provided with cooling ribs. The cylinder head has a hemispherically-shaped compression chamber. The scavenging operates in "reversed flow," namely, the inlet ports *C* and the exhaust ports *D* are in crosswise opposition. The initial difference or overlap in dimension between the cylinder bore and the external diameter of the liner, which is decisive for the press fit, is so gauged that in the proximity of the cylinder head it is greater than in the port region and below. Moreover, it is greater in the port region in the vicinity of the exhaust ports than in the vicinity of the inlet ports. Consequently, the pressure between the cylinder and the liner, with the engine in a cold condition, is more intense in the proximity of the cylinder head than in the port region. The liner is thus retained by a uniform medium force fit, mainly in the upper full section, whilst the pressure in the port region itself is so insignificant that, when pressing the liner in, no undesired deformation occurs. Furthermore, in the port region, somewhat closely above or below the ports, the pressure in the direction of the axis of the exhaust ports is greater than in the direction of the axes of the inlet ports. In the ports themselves there is no pressure. When the cylinder becomes hot in operation, the difference in thermal expansion between the cylinder surface and the liner, which is greater in some places than in others, is not sufficient to loosen the pressure in the proximity of the exhaust ports enough to cause the cylinder to be out of true. The pressure does in fact decrease more at the points of greater heat expansion than at other points. As, however, it already was higher from the start, a condition will arise during operation in which the liner is subjected all around to an approximately uniform compression. The rate of reduction of the initial difference in dimension from the top to the bottom may be uniform or vary smoothly or irregularly. The amount of difference may change abruptly at a given point or points.—*August* 10, 1955.

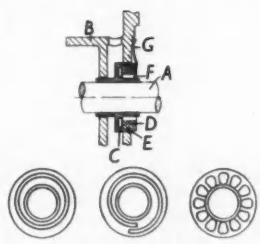


No. 735,067

POWER TRANSMISSION

735,250. March 3, 1953.—ROTARY SHAFT SEALS, Henschel and Sohn, G.m.b.H., 2, Henschelstrasse, Kassel, Germany. (*Inventor: Harald Hany.*)

The invention provides a rotary shaft seal, particularly suitable for turbo feed pumps, for preventing leakage of fluid medium under pressure by way of a circumferential clearance between a rotary shaft and an adjacent stationary part. The drawing shows a part-sectional view of a turbine rotor shaft, and part of the turbine casing, and the lower views show various forms of the rotary sealing disc. In the drawing *A* is the rotor shaft; *B* the casing, *C* a rotary sealing disc which rotates with the shaft, and *D* a co-operating non-rotatable sealing ring having a packing ring *E* let into a peripheral groove. The disc *C* and ring *D* co-operate to form the shaft seal. A clearance *F* is provided between the sealing ring *D*, which may be made of carbon, and the shaft. Leaf springs *G*, which are secured to an intermediate wall of the casing, press the ring *E* against the sealing face of the rotatable sealing disc *C*. The sealing disc employed in this construction is shown in face elevation in the lower view, from which it will be seen that the sealing face of the disc is provided with a series of recesses. The recesses are so placed and dimensioned that when the sealing disc and sealing ring are in their co-operating working positions, the fluid within the turbine casing can pass into the recesses by way of the clearance *F*, but is prevented from escaping by an uninterrupted zone of contact between the recessed sealing disc and the ring, located so as to surround the series of recesses. As a result, the effective sealing pressure between the sealing faces of the sealing ring and disc is less than the force exerted by the fluid on the non-sealing side of the sealing ring, the value of the effective sealing pressure depending on the length and breadth dimensions of the recesses. The wear on the relatively rotating parts of the seal and, in particular, on the sealing ring, which is of carbon or other self-lubricating solid material, is thereby considerably reduced. Alternative forms of rotatable sealing disc are shown in the lower left-hand and centre views.—*August* 17, 1955.

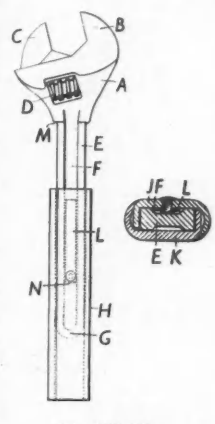


No. 735,250

TOOLS AND WORKSHOP APPLIANCES

735,318. October 9, 1952.—SPANNERS, Archibald Cuthill Wood, 17, Woodhouse Close, Perivale Middlesex, and Arthur George Avent, "Crofton," Brimley Avenue, Teignmouth, Devonshire.

It is the object of the invention to provide an improved construction of a spanner, in which the handle is adjustable in length so that the leverage obtainable may be readily adjusted. In the drawing the spanner is shown with a head *A*, including a fixed jaw *B* and a movable jaw *C*, variable by operation of a worm *D*. Integrally formed with the head *A* is a shank *E*, having a somewhat flattened "H" cross section, as will be seen from the side view, with a central longitudinal recess *F* which is terminated at the end of the shank remote from the head by the wall or rim portion *G*. Over the shank is engaged a tubular handle *H* consisting of two substantially C-shaped channel members *J* and *K*, welded or brazed together along the longitudinal edge portions. A suitably bowed leaf spring *L* is secured by a rivet to the inside of the handle and lies in the recess *F* whilst bearing against the shank. In the position illustrated the handle is about one half extended. In the fully retracted position the handle is engaged against the shoulders *M* of the head, whilst in the fully extended position the end *N* of the leaf spring *L* or the rivet abuts against the wall or rim portion *G* and prevents complete removal of the handle.—*August* 17, 1955.

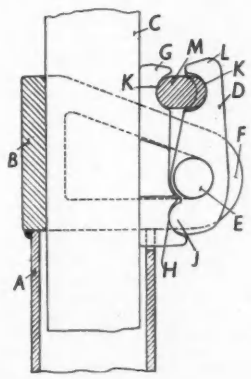


No. 735,318

MINING ENGINEERING

734,554. July 10, 1953.—PIT PROPS, Eisenwerk Wanheim G.m.b.H., Ehingerstr. 334, Duisburg-Wanheim, Germany.

The invention relates to pit props in which an inner prop element is clamped fast in an outer element. As will be seen from the drawing, an outer prop element *A* is connected by welding at its upper end to a lock housing *B*. An inner prop element *C* is introduced into the outer element *A*. A double-armed lever *D* is mounted in the eye of the lock *B* by a pivot pin *E* secured to the lever and engaging in the two straps *F* of the lock, which lie on both sides of the inner element *C* and of which only one can be seen in the drawing. An insertion element *G* forming a clamping member is set between the double-armed lever *D* and the inner element *C*. It has in its lower part a socket-like recess *H* of such form that the lower part *J* of the double-armed lever



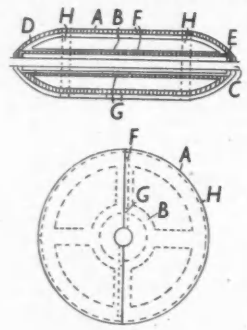
No. 734,554

engages in it. Similar recesses *K* are formed in the upper part *L* of the lever *D* and of the clamping element *G*. Disposed between the socket recesses *K* is a wedge *M* which can be driven in by hand. When the wedge *M* is driven in the lever *D* is forced outwards at the upper end *L*, at which the wedge *M* engages, and inwards at the lower end *J* where the lever arm engages in the recess *H*. Thus, the lever is tensioned. The inner prop element *C* is thus firmly clamped in the lock *B* and consequently with respect to the outer prop element *A* with a force corresponding to the angle of the wedge *M* and to the force with which this wedge is driven in.—*August* 3, 1955.

ELECTRICAL ENGINEERING

734,092. August 9, 1952.—SNOW CLEARING DEVICE FOR OVERHEAD LINES, Francis James Eckington, 1, Tingley Cottage, Ripe, near Lewes, Sussex.

The invention relates to a device which prevents snow from settling on overhead electric cables or lines. This is mounted on a cable so that the weight of snow forming on the uppermost surface of the device causes it to overbalance and throw the snow off. As the drawing shows, the device comprises a



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tubular body *A*, which may be in the form of a hollow shell having a central tube *B* forming the bore through which the cable *C* passes. The ends *D* and *E* are domed to space one device from another. The device is divided lengthwise into two parts to facilitate fitting and replacement. It may have supports to strengthen the body *A* and the tube *B*. Rebates *F* and *G* are provided to permit flush fitting of the two sections. Spring clips *H* clip the two sections together and rebates are provided in the body for the fitting of the clips. If desired, the device may be made without the tube *B*, and it is then supported on the cable by the bores of either end. The body or tube may be filled with any medium to prevent the device freezing to the cable. Fins may be added to effect overbalancing better or to enable the wind to rotate it.—*July* 27, 1955.

Launches and Trial Trips

ATHELSTANE, oil tanker; built by Hawthorn Leslie (Shipbuilders), Ltd., for the Athel Line, Ltd.; length overall 459ft, breadth moulded 61ft, depth moulded 31ft, deadweight 10,000 tons; twenty main cargo tanks, twelve summer tanks, one main cargo pump room, two horizontal duplex cargo pumps, two vertical duplex pumps for special cargoes and a rotary pump for molasses; two 100kW diesel-driven generators, one 50kW steam-driven generator; Hawthorn-Doxford oil engine, four cylinders, 670mm diameter by 2320mm combined stroke, 4450 b.h.p. at 112 r.p.m., two cylindrical boilers.—Trial August 30th and 31st.

CALAMARES, refrigerated fruit cargo ship; built by Cammell Laird and Co. (Shipbuilders and Engineers), Ltd., for Empresa Hondurena de Vapores, Honduras; length between perpendiculars 425ft, breadth moulded 59ft, depth moulded to upper deck 36ft, draught for scantlings 26ft; twelve passengers; four decks, four main cargo holds, eight 5-ton derricks, electric deck machinery, Denny-Brown stabiliser; three 400kW turbo-alternators, one 75kW diesel-driven generator; a two-cylinder articulated double reduction geared steam turbine, 9000 s.h.p. at 125 propeller r.p.m., steam supplied at 600 lb per square inch and 850 deg. Fah. by three Babcock and Wilcox sectional header single pass boilers.—Launch September 2nd.

HELDIA, oil tanker; built by the Wallsend yard of Swan, Hunter and Wigham Richardson, Ltd., for Shell Tankers, Ltd.; length between perpendiculars 530ft, breadth moulded 69ft 3in, depth moulded 39ft, draught loaded 29ft 7½in, deadweight 18,000 tons, service speed 14½ knots; thirty-three cargo oil tanks, one main cargo pump room, four 400 tons per hour cargo oil pumps, two stripping pumps, two 550kW turbo-alternators, one 200kW diesel-driven alternator; one set of double-helical double-reduction articulated gearing built by Wallsend Slipway and Engineering Company, Ltd., service power 7500 s.h.p. at 100 propeller r.p.m., maximum continuous power 8250 s.h.p. at 103 propeller r.p.m., steam supplied at 500 lb per square inch and 800 deg. Fah. by two Babcock and Wilcox boilers.—Launch September 2nd.

NINIVE, oil tanker; built by the Chantiers Navals de la Ciotat for the Compagnie Navale des Pétroles; length overall 651ft 3in, length between perpendiculars 607ft, breadth moulded 83ft 8in, depth moulded 43ft 8in, draught loaded 33ft, deadweight 29,600 tons, speed 15 knots; twenty cargo oil tanks; Burmeister and Wain "Mark 9·74 VTF/160" diesel engine, 11,250 b.h.p.—Trial September.

ISOCARDIA, oil tanker; built by the Chantier et Ateliers de Saint-Nazaire Penhoët for the Société Maritime Shell; length overall 660ft, length between perpendiculars 631ft, breadth 86ft 9in, depth 45ft, draught 33ft 11in, deadweight 31,500 tons; thirty cargo oil tanks, three 1300-tons per hour cargo oil pumps; two 550kW turbo-alternators, one 150kW diesel-driven alternator; one set of C.E.M.-Parsons double-reduction geared turbines 15,000 s.h.p. maximum, trial speed 16·7 knots with 13,750 s.h.p. at 105 propeller r.p.m., two Penhoët boilers supply steam at 640 lb per square inch and 840 deg. Fah.—Trial September.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Sept. 28th.—LONDON SECTION: School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Extending the Limits of Resistance Measurement Using Electronic Techniques," G. I. Hitchcox, 6.30 p.m.
Wed., Oct. 5th.—MERSEYSIDE SECTION: Chamber of Commerce, 1, Old Hall Street, Liverpool, 3, "Stereophonic Sound," R. A. Bull, 7 p.m.
Thurs., Oct. 6th.—N.W. SECTION: Reynolds Hall, College of Technology, Sackville Street, Manchester, "Colour Television," G. N. Patchett, 6.30 p.m.

CHEMICAL SOCIETY

Wed., Oct. 5th.—MANCHESTER BRANCH: Large Chemistry Theatre, The University, Manchester, "Inorganic Metallurgical Aspects of Atomic Energy," L. Rotheram, 6.30 p.m.
Thurs., Oct. 6th.—BRISTOL BRANCH: Chemistry Department, The University, Bristol, "The Impact of Nuclear Energy on Industry," J. M. Fletcher, 7 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Thurs. and Fri., Oct. 13th and 14th.—Conference Room, Campfield Avenue, Deansgate, Manchester. In connection with the Fuel Efficiency Exhibition (Wed., Oct. 12th to Sat., Oct. 22nd) the Association has arranged a Conference entitled "The Cost of Steam."

ENGINEERING INDUSTRIES ASSOCIATION

Wed. to Fri., Oct. 12th to 14th.—Royal Horticultural Society's New Hall, Greycoat Street, London, S.W.1, Eighth London Regional Display.

ILLUMINATING ENGINEERING SOCIETY

To-day, Sept. 23rd.—BATH AND BRISTOL CENTRE: S.W. Electricity Board, Old Bridge Street, Bath, "Interior Decoration and its Effect upon Illumination," J. D. Layton, 7 p.m.——BIRMINGHAM CENTRE: Regent House, St. Phillip's Place, Colmore Row, Birmingham, Chairman's Address, G. R. Hanson, 6 p.m.
Mon., Sept. 26th.—LEEDS CENTRE: Chemistry Lecture Theatre, The University, Leeds, "The Brightness of the Stars," Sir Harold Spencer Jones, 7 p.m.——LEICESTER CENTRE: E. Midlands Electricity Board, Charles Street, Leicester, "Interesting Lighting Jobs," Papers by Members, 6 p.m.
Wed., Sept. 28th.—TRANSVAAL CENTRE: Room 95, Public Library, Johannesburg, "The Study of Natural Daylighting Using Models," W. M. H. Rennhakkamp, 8 p.m.
Mon., Oct. 3rd.—LEEDS CENTRE: Yorkshire Electricity Board, Ferensway, Hull, "Stage Lighting," P. Corry, 7 p.m.
Wed., Oct. 5th.—NEWCASTLE CENTRE: Department of Electrical Engineering, King's College, College Road, Newcastle upon Tyne, 1, Chairman's Address, J. N. K. Rankin, 6.15 p.m.
Thurs., Oct. 6th.—GLASGOW CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "The Architect and the New I.E.S. Code," A. Buchanan Campbell, 6.30 p.m.——NOTTINGHAM CENTRE: E. Midlands Electricity Board, Smithy Row, Nottingham, Chairman's Address, P. A. Moore, 6 p.m.

INCORPORATED PLANT ENGINEERS

Mon., Sept. 26th.—W. AND E. YORKS BRANCH: The University, Leeds, "Axial Flow Fans," R. H. Holbeche, 7.30 p.m.
Tues., Sept. 27th.—S. WALES BRANCH: S. Wales Institute of Engineers, Park Place, Cardiff, "Space Heating," W. M. Barber, 7.30 p.m.
Wed., Sept. 28th.—SHEFFIELD AND DISTRICT BRANCH: Grand Hotel, Sheffield, "Steelmaking and the Plant Engineer," R. Mayorcas, 7.30 p.m.
Fri., Sept. 30th.—BIRMINGHAM BRANCH: Imperial Hotel, Birmingham, "The Do's and Don'ts of Refrigeration," Malcolm E. Lea, 7.30 p.m.
Tues., Oct. 4th.—LONDON BRANCH: Royal Society of Arts, John Adam Street, Adelphi, W.C.2., "Air Pollution Problems and their Cure," J. B. M. Mason, 7 p.m.
Wed., Oct. 5th.—SOUTHAMPTON BRANCH: Grand Hotel, Bournemouth, "Modern Trends in Heating and Ventilating," Colonel Concannon, 7.30 p.m.
Thurs., Oct. 6th.—MERSEYSIDE AND N. WALES BRANCH: Royal Institution, Colquitt Street, Liverpool, "Statutory Requirements in Connection with Boilers and Pressure Vessels," G. A. Anderson, 7.15 p.m.——PETERBOROUGH BRANCH: Campbell Hotel, Bridge Street, Peterborough, "Gas Turbines in Industry," J. R. Needham, 7.30 p.m.

INSTITUTE OF FUEL

Tues., Oct. 4th.—MIDLAND SECTION: Midlands Electricity Board's Lecture Room, Kingsway, Stoke-on-Trent, "National Fuel Resources in the Light of National Fuel Requirements," G. E. Foxwell, 7 p.m.
Wed., Oct. 5th.—LONDON SECTION: Institution of Civil Engineers, Great George Street, London, S.W.1, "The Effect of Coal Quality on the Efficiency of a Shell Boiler Equipped with a Travelling-Grate Stoker," E. J. Macdonald and M. V. Murray, 5.30 p.m.——YORKSHIRE SECTION: Royal Victoria Hotel, Sheffield, Chairman's Address, H. E. Pearsall, 2.30 p.m.
Fri., Oct. 7th.—S. WALES SECTION: S. Wales Institute of Engineers, Park Place, Cardiff, "Implications of the Rivers (Prevention of Pollution) Act, 1951," A. H. Williams, 6 p.m.

INSTITUTE OF PETROLEUM

Wed., Oct. 5th.—STANLOW BRANCH: Grosvenor Hotel, Morecambe, "Development of Oil Cracking as a Source of Raw Materials for the Polymer and Plastics Industry," J. W. Woolcock, 8.30 p.m.

INSTITUTE OF PHYSICS

To-day and Sat., Sept. 23rd and 24th.—ELECTRONICS GROUP: 47, Belgrave Square, London, S.W.1, "Some Recent Developments in Magnetic Materials," Symposium.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Tues., Sept. 27th.—N.E. CENTRE: Three Tuns Hotel, Durham, "Gas Turbine Development for Road Transport," P. A. Phillips, 7 p.m.

INSTITUTE OF WELDING

Thurs., Sept. 29th.—N. LONDON BRANCH: Manson House, Portland Place, London, W.1, Presidential Address, "Recent Advances in Welding Processes and Plant," J. H. Paterson, 7.30 p.m.
Wed., Nov. 2nd, to Fri., Nov. 4th.—Autumn Meeting, London.

INSTITUTION OF CIVIL ENGINEERS

Wed., Sept. 28th.—MIDLANDS ASSOCIATION: Visit to inspect new developments at the Sewage Works and progress on the reconstruction of the City Centre. Assemble in Council Chamber, Council House, Coventry, 11.45 a.m.
Tues., Oct. 4th.—AIRPORT MEETING: Great George Street, Westminster, London, S.W.1, "Selected Aspects of the Geometric Design of Airports," John Hugh Jones, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Sat., Oct. 1st.—Visit to Brunswick Wharf Generating Station, 10.30 a.m.
Thurs., Oct. 6th.—ORDINARY MEETING: Savoy Place, London, W.C.2, Inaugural Address as President, Sir George H. Nelson, Bt., 5.30 p.m.
Mon., Oct. 10th.—Savoy Place, London, W.C.2, Chairman's Address, "A.C. Switchgear," M. H. F. Collins, 6.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Oct. 4th.—39, Elmbank Crescent, Glasgow, Presidential Address, A. M. Robb, 7.30 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE

Wed., Oct. 12th.—St. Bride's Institute, Bride Lane, Fleet Street, London, E.C.4, Presidential Address, R. L. Quertier, 6.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Fri., Oct. 7th.—LONDON BRANCH: Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "Aerial Surveys and Practical Application of Results Therefrom," Joint Papers, Hunting Aerosurveys, Ltd., and B. F. J. Bradbeer, 5.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Wed., Oct. 5th.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "The British Railways Mechanical Iron Foundry, Horwich," S. A. S. Smith, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Fri., Oct. 7th.—AUTOMOBILE DIVISION: 1, Birdcage Walk, Westminster, London, S.W.1, Annual General Meeting. Address by Chairman of the Division, 5.30 p.m.

INSTITUTION OF NAVAL ARCHITECTS AND INSTITUTE OF MARINE ENGINEERS

Wed., Sept. 28th.—SOUTHERN JOINT BRANCH: Visit to the Submarine Establishment, H.M.S. "Dolphin," Fort Blockhouse, 2.45 p.m.; College of Technology, Anglesey Road, Portsmouth, "The History and Development of Submarines," R. N. Newton, 7.30 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Tues., Oct. 4th.—ORDINARY MEETING: Institution of Electrical Engineers, Savoy Place, London, W.C.2, "Radio Aids to Marine Navigation," W. Dolman, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, Sept. 23rd.—S. WALES AND MONMOUTHSHIRE SECTION: S. Wales Institute of Engineers, Park Place, Cardiff, "Extrusion of Metals," J. T. Lewis, 7 p.m.
Tues., Sept. 27th.—LUTON SECTION: W. H. Allen, Sons and Co., Ltd., Queens Works, Bedford, "Materials Handling," K. B. Warwick and H. Dean, 7.30 p.m.
Mon., Oct. 3rd.—E. AND W. RIDINGS REGIONAL MEETING: Chemistry Lecture Theatre, The University, Leeds, 2, "Valid Incentives," E. C. Gordon England, 7 p.m.
Wed., Oct. 5th.—NOTTINGHAM SECTION: Victoria Station Hotel, Nottingham, "Packaging," E. H. Dickens, 7 p.m.——S. ESSEX SECTION: Mid-Essex Technical College, Chelmsford, "Training of Production Managers and Production Engineers," G. S. Bosworth, 7.30 p.m.
Thurs., Oct. 6th.—READING SECTION: Great Western Hotel, Reading, "Production Control as Applied to Small and Medium-Size Companies," F. T. Hunter, 7.30 p.m.

IRON AND STEEL INSTITUTE

Wed. to Fri., Oct. 12th to 14th.—Special Meeting in Scunthorpe.

MANCHESTER GEOLOGICAL AND MINING SOCIETY

Thurs., Oct. 6th.—Mining and Technical College, Wigan, 117th Annual General Meeting, 3.15 p.m.

ROYAL AERONAUTICAL SOCIETY

Thurs., Oct. 6th.—BRITISH COMMONWEALTH AND EMPIRE LECTURE: Royal Institution, 21, Albemarle Street, London, W.1, "The Growth of Aeronautical Research in Canada During the Post-War Decade," J. J. Green, 6 p.m.

SHEET AND STRIP METAL USERS' TECHNICAL ASSOCIATION

Mon. and Tues., Oct. 10th and 11th.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, Special Conference on Modern Materials.